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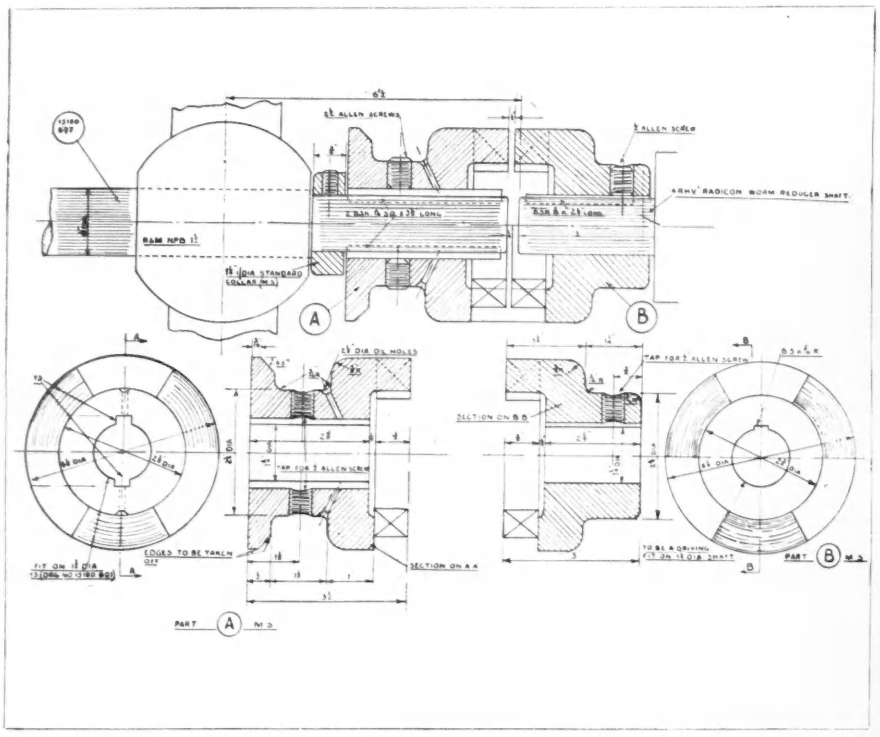

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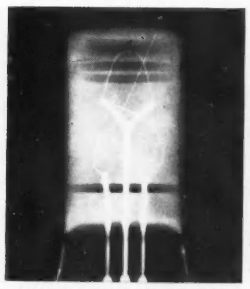

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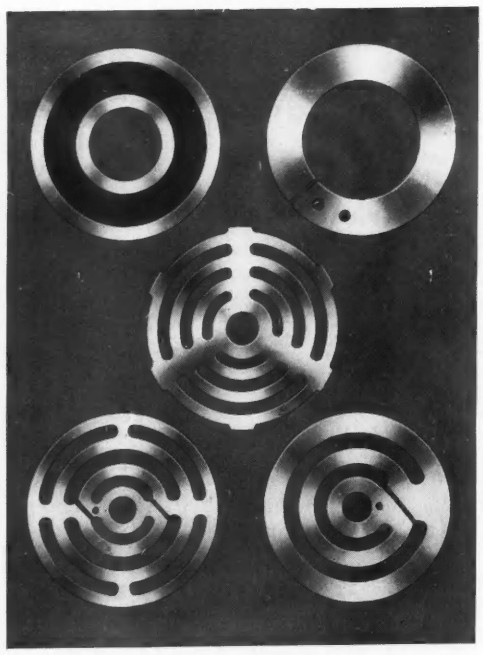

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The Salvage of H.M.S. "Thetis"

ON Thursday, July 20th, it was reported by the Liverpool and Glasgow Salvage Association that the salvage work on the "Thetis" had been interrupted by a moderate swell on the rising tide, but on Thursday's tide it was possible to pass the seventh and eighth ropes under the keel of the sunken submarine. All was ready on Saturday, when an attempt was made to lift the wreck. Unfortunately, this first attempt failed. An examination established the fact that, instead of the load of the submerged submarine being distributed over the eight 9in. lifting wires which were secured to the salvage ship "Zelo" at sixteen points, there was a concentration of at least 75 per cent. of the total load on two wires only. This maldistribution was caused by the strong tides sweeping away the wires from the positions which had been allotted to them. They also prevented the divers from checking the positions of the wires just before the lift was made. The heavy loading of the two wires caused, however, no breakage or damage other than the twisting of two wooden beams or baulks across the deck of the "Zelo" to which the wires were attached. As it was possible that the twisting might increase during the movement inshore, it was decided that it would be imprudent for the "Zelo" to leave her moorings. The Admiralty invited representatives of Cammell Laird and Co., Ltd., and the Liverpool and Glasgow Salvage Association to a conference held at the Admiralty on Thursday, July 27th, at which the salvage plan was discussed. In reply to a question put in the House of Commons on Monday, Captain A. Hudson, Civil Lord of the Admiralty, said that as long as there was a reasonable possibility of salving the "Thetis," he thought that it would be generally agreed that operations should continue, so that the fullest information might be available as to the cause of the accident.

Postponement of the Machine Tool Exhibition

WITH reference to the postponement of the Machine Tool Exhibition which was to have been held in 1940, referred to in our Journal note and leading article of June 30th, the Secretary of the Machine Tool Trades Association announces, in view of possible misunderstanding, that this step was only taken after the most careful weighing of all considerations and in consultation with H.M. Government representatives. No coercion was exercised from any quarter. The first suggestion of doubt as to the wisdom of proceeding with the arrangements came from within the membership of the Association. Further uneasiness developed in view of the changing situation, and, following representations to the Government as to the implications of preparing for and holding an exhibition under existing conditions, a letter was received expressing the official view that it would be inopportune to continue the arrangements. The views of the members were sought and the recommendation of the Council to postpone the Exhibition was unanimously endorsed. It is, says the Machine Tool Trades Association, obviously impossible, in the present circumstances, to forecast the date of the holding of the postponed Exhibition, but that date will not be deferred unduly, having regard to the progress of events.

London Civil Airports Joint Committee

IN a written reply to a question in the House of Commons on Tuesday, July 25th, the Secretary of State for Air, Sir Kingsley Wood, said that a London Civil Airports Joint Committee had been appointed, representing the Air Ministry and the Corporation of London, as the two parties owning the London terminal airports, and it would meet on Wednesday to deal with matters connected with the allocation of air traffic and traffic receipts. The Chairman of the Committee is the Parliamentary Under-Secretary of State for Air, Captain Balfour, and the representatives of the Secretary of State for Air are Sir Francis Shelmerdine (Director-General of Civil Aviation), Sir Harold Howitt, and Mr. Whitney Straight; while the Corporation of the City of London is represented by Alderman F. Horner (the Chairman of the Airport Committee of the Corporation), Mr. Sheriff Rowland, and Alderman Colonel Whitaker. The joint secretaries of the Committee are the Deputy Director-General of Civil Aviation and the Town Clerk. The terms of reference of the Committee are as follows:—"To make proposals to the Secretary of State for Air and to the Corporation of London for the allocation as between the Air Ministry and the Corporation of the total traffic receipts from the London airports. To consider plans for the allocation from time to time of air traffic between the existing and projected terminal airports serving the London area, namely, Croydon, Heston, Fairlop, and Lullingstone, and to advise the Secretary of State thereon. Further to consider other matters from time to time relating to terminal airport organisation and administration in the London area, and to make recommendations to the Secretary of State for Air." On Tuesday a far-reaching agreement which will effect the air traffic at the London airports was signed by Imperial Airways, Ltd., and Air France. Under the agreement, the two companies will pool their resources and will share their receipts. The new plan will provide twenty services each way between London and Paris every day during the summer, while during the winter there are to be fourteen services each way every day instead of the nine services which were run last year. It is expected that the new scheme will be put into operation at the beginning of the winter season.

A Ministry of Supply Advisory Panel

ON Tuesday, July 25th, it was made known by the Minister of Supply, Mr. Leslie Burgin, that as the work of the Ministry develops, advisory panels will be formed to assist the different branches of work embraced. The first of these will be an Advisory Industrial Panel, and on this panel the following have agreed to serve:—Mr. George Bailey, director of the Metropolitan-Vickers Electrical Company, Ltd., and the British Thomson-Houston Company, Ltd.; Mr. Peter Bennett, President of the British Federation of Industries and chairman of Joseph Lucas, Ltd., and a director of Imperial Chemical Industries, Ltd.; Mr. Oliver Boden, the managing director of the Nuffield Mechanisation and Aero Company, Ltd.; Commander Sir Charles Craven, chairman and managing director of Vickers-Armstrong, Ltd.; Mr. C. R. F. Engelbach, Past-President of the Engineering and Allied Employers' Federation and works director of the Austin Motor Company, Ltd.; Lord Dudley Gordon, chairman of J. and E. Hall, Ltd., and President of the British Engineers' Association; Mr. A. J. Grant, managing director of Thomas Firth and John Brown, Ltd., and Master Cutler; Sir Alfred Herbert, chairman and governing director of Alfred Herbert, Ltd.; Sir James Lithgow, chairman of the Fairfield Shipbuilding and Engineering Company, Ltd., and other steel and shipbuilding firms; Mr. A. C. Macdiarmid, chairman of Stewarts and Lloyds, Ltd., and director of several other steel firms; Mr. F. E. Rebbeck, chairman of Harland and Wolff, Ltd.; Mr. J. Rogers, a member of the board of Imperial Chemical Industries, Ltd., who has had considerable experience in the manufacture of explosives; and Lord Woolton, formerly Sir Frederick Marquis, who is chairman and managing director of Lewis's, Ltd., and who earlier in the year was appointed Honorary Adviser to the Minister of War and the Minister of Supply on matters connected with the production of Army clothing and textile equipment.

New Naval and Mercantile Shipbuilding Orders

ON Monday, July 24th, it was officially announced by the Admiralty that, subject to the settlement of certain points, it had been decided to entrust the construction of two mine-sweepers of the 1939 programme to each of the following firms:—The Ailsa Shipbuilding Company, Ltd., of Troon, Ayrshire, with machinery by John I. Thornycroft and Co., Ltd.; William Hamilton and Co., Ltd., of Port Glasgow, with machinery by J. Samuel White and Co., Ltd., and Harland and Wolff, Ltd., of Govan, Glasgow. This order completes the orders for mine-sweepers, the contracts for the four other similar ships having been placed on July 7th with the Blyth Dry Docks and Shipbuilding Company, Ltd., of Blyth, and with William Denny and Brothers, Ltd., of Dumbarton, the machinery being built by White's Marine Engineering Company, Ltd., and Harland and Wolff respectively. Early in the week it was announced that the Administration de la Marine has ordered from the British Power Boat Company, Ltd., of Hythe, Southampton, for the Belgian Air Ministry, two 37ft. 6in. aircraft tenders of a type generally similar to those used by the Royal Air Force. The boats will be fitted with British wireless telephony apparatus and searchlight gear adapted for their particular requirements by the builders. In addition, they are to be fully bonded and screened for radio reception and transmission. A mounting for a machine gun will be carried on the wheel-house roof. After trials have been carried out at Southampton, the craft will proceed to Belgium by sea under their own power. Delivery is expected in about eight weeks. The London, Midland and Scottish Railway Company has placed an order with the Fairfield Shipbuilding and Engineering Company, Ltd., of Govan, Glasgow, for two twin-screw fast turbine steamers for its Holyhead and Kingstown service. The new ships are to have a length of 390ft. and a beam of 54ft., and they will be designed to carry 2000 passengers each, 750 first-class and 1250 third-class, suitable provision being made for both day and night travel. It is expected that the new steamers will enter the company's service in 1941. The Greek Ministry of Marine has placed with Yarrow and Co., Ltd., of Scotstoun, Glasgow, an order for the boilers and machinery of two destroyers, which are to be built at the new shipyards of the Greek Government at Scaramanga. The new destroyers are of the British Admiralty "H" Type, and will be sister ships to the "Vasilevs Georgios I" and "Vasilissa Olga" which were launched on the Clyde last year.

Central Electricity Board

THE Central Electricity Board has received from the Electricity Commissioners an amending electricity scheme for North-West England and North Wales, providing for the Whitebirk generating station of the Blackburn Corporation to become a selected station, and for two new stations, with first sections comprising not less than 60,000 kW of generating plant, to become selected stations if and when they are duly authorised. It also makes provision for certain alterations in respect of the main transmission lines and transforming stations scheduled in the original scheme. Copies of the scheme, entitled the North-West England and North Wales (Alteration and Extension) Scheme, 1939, together with an explanatory memorandum prepared by the Commissioners, were available at the Stationery Office on Saturday, July 22nd. It is stated in the memorandum that the Commissioners have made the scheme upon representations by the Central Board regarding the prospective plant requirements of the scheme area. The Board informed the Commissioners that as a result of a review of those requirements they had come to the conclusion that, in addition to the extensions of the present selected stations in course of construction or contemplated, and apart from the selection of the Whitebirk (Blackburn) station and the construction, at a later date, of the Carrington station provided for in the original scheme, it would be necessary to take steps for the establishment of two other new stations in the area, one in time to meet the estimated demand arising in the Wirral neighbourhood in the year 1942–43, and the other to meet the anticipated growth in the demand in the area in later years. The alterations in the transforming station positions and transmission line routes were found in the course of the construction of the grid to be conducive to economy and security and were carried out by arrangement with the undertakers concerned and with the approval of the Commissioners.

The "Thetis" Enquiry

FURTHER evidence given before the Tribunal appointed to enquire into the loss of the submarine "Thetis" on Wednesday, July 19th, included that of Admiral Sir Martin E. Dunbar-Nasmith, V.C., Commander-in-Chief at Portsmouth, who is Chairman of a Committee appointed by the Admiralty to consider the future of submarine policy in the light of the recent disaster. He outlined in the course of his evidence some of the recommendations which had already been made by the Committee. They included, he said, further research on the possibility of fitting telephones and lights to the indicator buoys; the modification of the stern of a submarine so that escape might be possible should the stern be above water; the provision of safety clips to prevent the rear door of a torpedo tube being opened when the bow cap was opened; and the improvement of the air conditions in submarines when more than the normal crew was on board. Mr. Thomas Mackenzie, the chief salvage officer at Scapa Flow, who with two divers volunteered his services to the Admiralty and Cammell Lairds, described the work done on the site, and its suspension when the "Thetis" sank again. He told Mr. Justice Bucknill that, in his opinion, it would have taken only five to seven minutes to cut a hole in the "Z" tank and a similar time to cut a hole through the bulkhead into the pressure hull, using ordinary oxy-acetylene apparatus. Sir Stanley Goodall gave evidence on matters relating to submarine design, and a scheme of salvage was outlined by Mr. E. F. Cox, of Cox and Danks, Ltd. On Thursday, Professor J. B. S. Haldane, of London University, described his experimental reproduction in a steel cylinder of conditions approximating to those inside the "Thetis." From his own experience, Professor Haldane was able to state that the men suffered no severe pain other than headaches and nausea. Captain Oram was again called and gave further evidence on the policy of escape. Mr. Justice Bucknill made it known that he was anxious to hear the evidence of the divers before he made his report, and the Tribunal was then adjourned until Thursday, July 27th, when a meeting was to be held to fix the possible date for resuming the enquiry.

A History of Rotary Engines and Pumps

PART II.—No. I

The Twentieth Century

IN the first part of this series, which appeared in our issues during the first few months of the present year, we traced the history of the positive-acting rotary from the earliest times up to the end of the nineteenth century. We now propose to carry that history forward to include description of machines made at the present day.

At the end of the nineteenth century a doom was laid upon the hopes of inventors of rotary steam engines by the advent of the steam turbine. But, of course, that fact was not at once realised, and the invention of rotary steam engines continued well into the present century and has not even to-day completely died out. Nevertheless, as the success of the turbine became increasingly more and more apparent the more sensible inventors abandoned hope and only the futilitarians were left obstinately attempting a thing which had by now become impossible. The elimination of the steam engine as the goal towards which inventors had striven for over a century left the field open for more practicable propositions. A few inventors were led astray by the development of the internal combustion engine and began an attempt which has been continued until this day to devise a positive-acting rotary internal combustion engine, a machine the invention of which must seem to all but ardent enthusiasts even more hopelessly impossible than that of the steam engine. But the better-informed inventors resolutely turned their backs upon prime movers and set about the development of rotary pumps, blowers, compressors, meters, and compressed air motors. In the latter

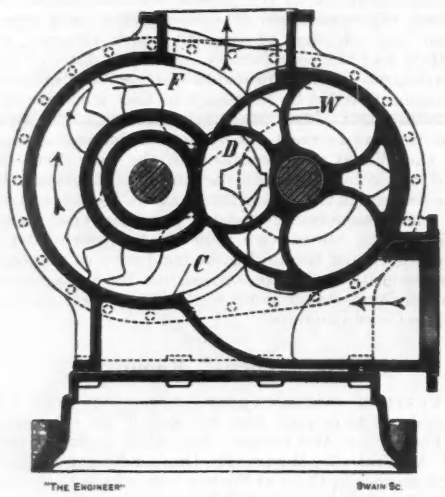


FIG. 1—ENKE PUMP—CIRCA 1910

half of the nineteenth century certain machines of these secondary classes had achieved considerable success, notably the Roots blower and the Greindl pump, amongst others. It seemed, therefore, that in these fields lay a greater hope of devising a useful machine, and as the twentieth century grew older the number of patents grew apace.

For a time the attention given to rotary pumps bore fruit in some profusion. During the decade that preceded the war even the strong competition of the centrifugal pump, then undergoing rapid improvement, seems to have been successfully met. The Connersville concern in America, for instance, built pumps in capacities up to 1·5 million gallons per hour for the rice irrigation districts of Louisiana and Texas. They were bi-rotor machines, with rotors of a slightly modified Roots form up to 52in. long by 58in. diameter, with a displacement of as much as 500 gallons per revolution. The "Acme" pump, popular during that period, had rotors something like those shown in the drawing Fig. 101 in article No. XV of the first part of this series, and was constructed in capacities up to 80,000 gallons per hour. A German pump, the "Enke" machine, illustrated in Fig. 1, had capacities up to 200,000 gallons per hour and had the distinctive quality that it gave a theoretically uniform discharge. Among smaller machines, the Greindl and the Goldschmidt-Haklo had survived from the previous century, the Colebrook was a revival in a somewhat improved form of Benjamin Beale's engine of 1841, Baker's blower was still being manufactured, and there were a number of other gear and "Crescent" designs.

But the rotary is not at its best when pumping a fluid with no lubricating qualities, since wear tends to become excessive. Its period of success as a large water pump appears, therefore, to have been brief. Soon, as the centrifugal proved its superiority, the rotary was relegated to minor duties in those very small capacities which are too low for the centrifugal to develop its full efficiency. To-day, apart from certain more specialised fields which will be mentioned later, the rotary pump is used almost solely for comparatively minor services in which its compactness and its simplicity combine to recommend it. Among its more common applications may be mentioned the forced lubrication of a large variety of machines and mechanisms, the supply of cutting lubricant to machine tools, and the forcing of the hydraulic medium in small presses and rams. Generally speaking, the modern rotary pump is a small device performing a humble, but necessary, duty. In this field it gives excellent and trouble-free service.

While the rotary pump was being developed to compete for a while with the centrifugal, many inventors also gave their attention to the possibility of developing a practicable gas compressor. The particular advantage of the Crescent form of design for that service was soon recognised. But many years had to pass before a simple means was discovered to overcome certain important practical defects and it was not until after the war that really practical and reliable designs seem to have been evolved. By that time, however, the turbo-compressor had also been fully developed and the rotary was able to compete with it only in capacities of less than about 3000 cubic feet per minute. For the efficiency of the turbo machine tends to fall away in the smaller sizes, whilst the loads on the bearings of rotaries become excessive in larger sizes. Rotary compressors are therefore now made in capacities up to about 3000 cubic feet per minute for pressures up to about 50 lb. per square inch. In recent years small turbo machines have been improved and unless corresponding improvements can be made to the rotary it seems likely that its field of usefulness may become even more restricted than it is at present.

Rotary blowers, by which is meant machines only capable of delivery against pressures below about 5 lb. per square inch, had already been invented and found a field of usefulness early in the second half of the nineteenth century. Their use has continued without check to the present day. The more important example is the Roots machine, but other designs of various forms have been developed and are still used for more particular purposes. Typical applications are the supply of air to steel converters and metal melting cupolas, agitation in ice-handling plants, and the service of pneumatic conveyors.

The development during the present century of compressed air operated tools has encouraged the invention of rotary air motors particularly adapted for that service. It is particularly important in this application that the motor shall be compact. But competition has also led to a demand for economy in the use of the air. Curiously enough, the reciprocator, the turbine, and the rotary, each of which in other fields appears to have its own special place, apparently compete in pneumatic tools on almost equal terms, so closely balanced are the advantages and disadvantages of each.

Rotary mechanisms are to this day used as meters, and several different designs are in use. Their compactness and positive-acting qualities combine to recommend them for this service, whilst, since the pressure difference across them is small, leakage becomes almost negligible and friction very small.

Recent Developments

It will be observed that the rotary, generally speaking, occupies a very humble position among the machines that the engineer employs. It is, in fact, in many applications, only used at all because in small sizes the efficiency of some other and otherwise more preferable machine is not sufficiently high. In comparatively recent years, however, certain fields of application have been found in which, by reason of its special qualities, the rotary is able to compete on equal terms with other types of machine and with at least as good a chance of survival. An instance is provided by the mechanisation of the coal mining industry. Compressed air has notable advantages for operating tools in mines as compared with electricity on account of its safety. Air motors in sizes up to about 100 H.P. have been developed to drive coal-cutting machinery and conveyors. These motors are rotary machines. In aircraft, to quote another instance, the use of retractable undercarriages, and the development of rotatable gun turrets, and other things operable by hydraulic means has led to a demand for a small positive-acting pump, very light and compact, and capable of delivering against a very high pressure. For that service the positive-acting rotary has obviously specially advantageous characteristics, providing it can be constructed to stand up to a very stringent specification regarding reliability and longevity. Much work is being done in that field with the object of developing a suitable appliance.

But perhaps the field of greater importance that seems to provide the very best chance for the development of the rotary has opened out as a result of the requirements of the oil industry. In this field larger pumps than any required elsewhere are demanded, and the demand grows greater every year. Pumps in capacities up to at least 1000 gallons per minute, able to deliver against pressures up to 750 lb. per square inch, and to draw hot or viscous fluids against high vacua, are wanted, and it is desirable that they should operate at speeds high enough to allow them to be directly connected to electric motors. Their efficiencies should be at least comparable with those of reciprocating pumps performing the same duty. In many cases they are required to pump fluids at temperatures up to 350 deg. Cent. or so. This article, concerned, as it is, with history, is scarcely the place for a full technical description of the reasons why it is

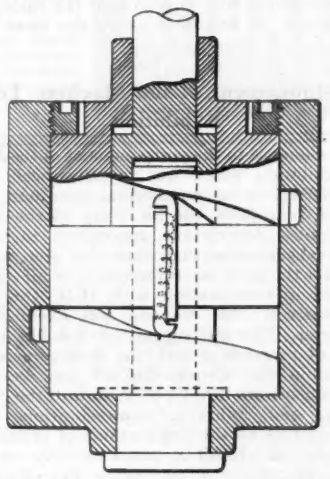


FIG. 2—PITTLER—1900

believed that rotary pumps may have particular advantages for this service not possessed either by centrifugals or reciprocators. It may, however, be pointed out that the pumps are required to handle viscous fluids and hot fluids which may get into a frothy condition when agitated. The reciprocator suffers the disadvantage that the speed at which it can be run is limited by the reluctance of the viscous fluid to follow up behind the piston on the suction side; and its efficiency is reduced by losses in forcing the fluid past the suction and discharge valves. Moreover, its delivery is far from being uniform and further losses are incurred by the cyclical acceleration and retardation of the fluid in the suction and discharge pipes. The centrifugal, it is true, has the advantage of a pulseless suction and delivery, but its efficiency is very adversely affected by the difficulty of converting the kinetic energy of flow of a viscous fluid into pressure energy without incurring heavy losses by fluid friction, and its performance is likely to be adversely affected if frothiness develops on the suction side.

It is, however, by no means impossible to devise a rotary which has, at least theoretically, an absolutely uniform discharge and which can therefore—since it imposes no accelerations and decelerations on the fluid in the suction and discharge pipes—be run at a high speed. No losses will be incurred by the conversion of kinetic into pressure energy, since the pressure is generated directly, as in the reciprocator; and the passage through which the liquid flows need not be obstructed by

valves or other obstacles. Owing to its positive-acting quality, moreover, the rotary machine has the advantage that it cannot be put out of action by the leakage of air into the suction pipe—a point of some importance on shipboard in a seaway, when the liquid may be surging back and forth in a partially empty tank—and will be unaffected by the presence of froth. Few firms seem yet to have entered upon this field. But those that have now manufacture rotary pumps in sizes larger than those employed for any other duty.

There are, in addition, a number of other applications too numerous to mention individually. Rotary pumps are used, for instance, for pumping tooth paste, wines, treacle, milk, and many other materials, and have the advantage of other forms of pump through the ability to work without lubricant in the pumping chamber, because no churning occurs, or for other special reasons.

In dealing with the history of rotaries in the present century we intend to adopt much the same

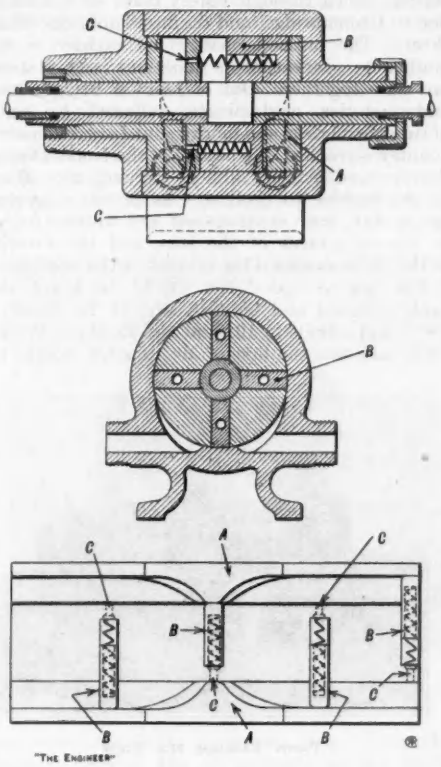


FIG. 3—PITTLER—1901

classification and arrangement as that used for the first part of this series. The particulars given are those which have come to our knowledge as a result of the examination of numerous patent specifications and contemporary journals, books, &c. We make no claim, however, that the information approaches completeness. At least, in our opinion, an exhaustive search to discover as much as possible that is recorded about each machine described would not justify the amount of time and labour involved. Nor do we suggest that the articles will completely cover the whole field of rotaries during the twentieth century. So many machines were patented that it is a hopeless task to attempt to discover what happened to each of them. We have shamelessly picked and chosen among the hundreds of proposals and refer in this series only to those which seem to us to be of interest because they had an influence on the design of modern machines, because of their mechanical ingenuity or merely because they exhibit depths of futility that would be scarcely credible had not the inventors taken out patents.

ROTARY PISTON MACHINES

Rotary piston machines had proved popular with inventors throughout the nineteenth century and they have continued to remain relatively popular during the present century. Nevertheless, very few original designs have been put forward during the past forty years. Most of the proposals relate either to the rediscovery in a more or less closely identical form of older designs or are concerned in effecting minor and, it is to be feared, usually worthless improvements of them. In consequence we shall limit our references to two machines now, we believe, out of production and to two other machines which have recently been put upon the market.

1900/1748: *Wilhelm von Pittler*.[1]—Although Wilhelm von Pittler lived at Leipzig, there is some doubt, which we have not yet been able to clear up, as to whether he had any connection with the modern machine tool firm, Firma Pittler A.G. The pump or engine subject of his first patent, differed very little from the similar machine suggested as early as 1838 by Thomas Walker and described in article No. VI of the first part of this series. The rotor as shown in an accompanying, sketch, Fig. 2, consisted of a somewhat thick disc, in which there was a radial slot. A blade was mounted in the slot and was capable of sliding back and forth axially within it. The rounded ends of the blade bore against guides with helically cut faces surrounding the shafts and held within the cylinder at each end. Suitable ports were arranged to permit the working fluid to be admitted to and released from the alternately enlarging and contracting spaces on each side of the disc. Apart from minor constructional differences, the only change from Walker's scheme suggested by Pittler related to the design of the blade. It was to be made in two pieces, between which a compression spring was to be interposed with the object of holding the ends tight against the helical guides. This arrangement seems to have suggested to Pittler the idea of a single-sided device. For it is also proposed that there should be only one helical guide and

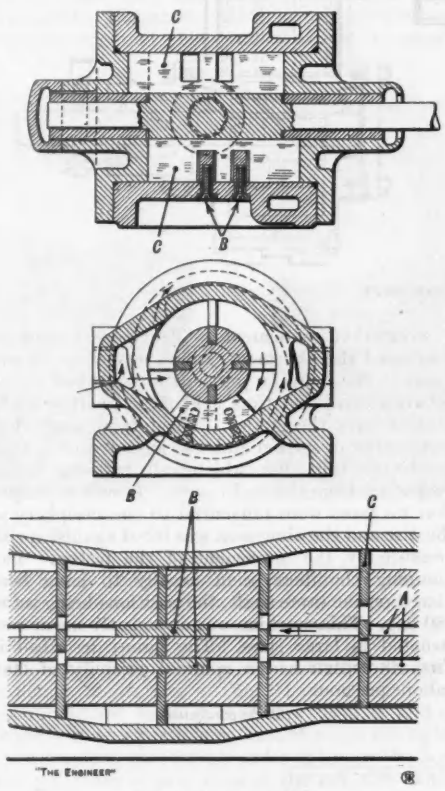


FIG. 4—PITTLER—1907

that the blade should be pressed out of a blind slot in the rotor by compression springs.

Within a year the machine was considerably modified. Helical guides were discarded. Instead, they were made flat over the greater part of their surfaces, but with a cam-shaped axial projection A, as shown in Fig. 3, in which the shape of the projection is best shown in the developed section view. There were four blades B, spring pressed from blind axial slots in the rotor disc, two sliding towards one guide and two towards the other. Holes C were bored through from the bottoms of the slots and allowed fluid from the further side of the disc to act behind the blades, thus balancing the fluid pressure thrusting them inwards, and making it possible to use light springs and so to reduce friction. A year or two later it was realised that contact between the disc and the tops of the cam guides was unnecessary so long as there was a sufficient number of blades and providing that the length of the top of the cam was greater than the peripheral distance between the blades.

The next step in the development of the device was taken in 1907. A reversion was made to the use of blades projecting right through the disc and running between the two axial guides, the shapes of which now became complementary. Radial slots A were cut into the periphery of the disc—Fig. 4—and "abutments" B were mounted on

[1] *Mechanical Engineer*, Vol. XX, page 584; *Engineering*, Vol. LXXXIV, page 421; Patents 1901/20,745, 1904/25,377, 1907/5081 and 5081A, 1909/29,777.

the cylinder to engage with these slots. The blades C were also formed with radial slots and, when they were forced across axially by the cam guides, these slots, until then hidden within the body of the disc, coincided with the slots of the disc, so that the blades were able to pass the "abutments."

In the same patent the same idea was applied to a machine with blades that moved radially—Fig. 5. The rotor consisted of a disc A, from which a number of concentric drums B C D projected axially on each side. These drums were slotted to take four radial blades G, which were forced to move in and out in contact with a shaped cylinder by a central fixed cam E. "Abutments" F were supported on the end covers and fitted into the spaces between the concentric drums; and axial slots in the blades allowed them to pass the abutments when forced out by the central cam. It was suggested that the arrangement would be particularly suitable for an expansive steam engine. The steam was to be admitted first to the innermost chamber and expanded radially in succession through the others, the volumes of which increased,

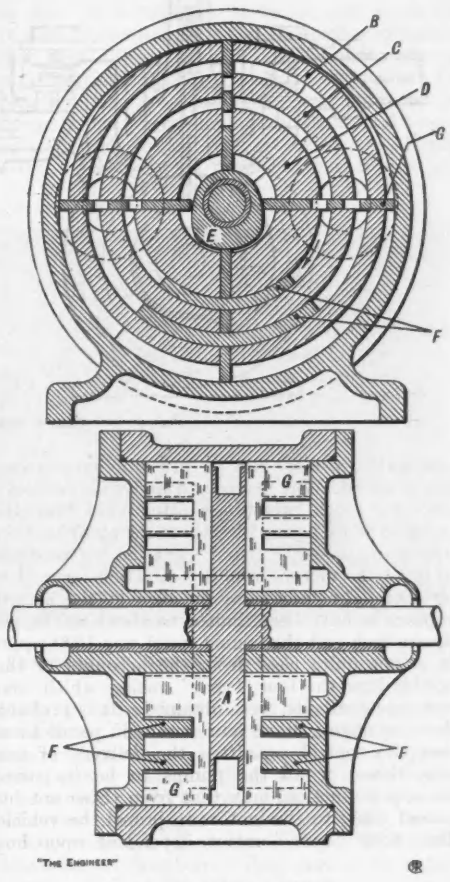


FIG. 5—PITTLER—1907

of course, in proportion to their radial distance from the centre.

Pittler seems to have intended his machines for use with distinctly high pressures up to as much as 1000 lb. per square inch. For that kind of service it is a definite advantage in reducing shocks and general wear and tear if the delivery can be made not merely continuous, but invariable. In 1909, therefore, Pittler took out a patent, which is concerned with machines of the type shown in Fig. 3, showing how the cam guides can be so formed that the delivery becomes constant providing there is a certain minimum number of blades.

How much success actually attended the Pittler machine we have been unable to determine at all precisely. The succession of patents between 1900 and 1909 rather suggests that uses had been found for it. But we have found references only to one occasion on which the machines came before the public notice in this country. Examples of the machines were exhibited in the forms of pumps and hydraulic motors at the Engineering Exhibition held at Olympia in 1907. All the three pumps shown were claimed to have an efficiency of 90 per cent. and were of the axial form. The following table gives some particulars of them:—

Delivery, g.p.h.	Head, feet.	R.p.m.	Weight, lb.
1,500	1,500	1,000	40
6,000	2,000	1,000	112
13,000	1,000	1,000	125

It will be observed that the machines were notably light in relation to their output and that the largest was of a quite respectable size. Similar

machines used as motors, it was said, could be expected to realise an efficiency of 85 per cent.

The machines seem to have been marketed in this country by the Pittler Universal Rotary Machine Syndicate,[2] of 81, High Holborn. At the time of the exhibition an endeavour was being made to develop the device to replace the conventional transmission gear of motor cars and one of the exhibits was intended to show the suggested alternative transmission. Unfortunately, the accounts of this exhibit are not quite as precise as we could wish in detail, although the general idea is clear enough. The engine was directly connected to a Pittler pump, which delivered fluid, probably oil, to two hydraulic Pittler motors contained in the back axle, where the differential would ordinarily be placed. As each motor independently drove one rear wheel a differential action was retained. The driver had under his control a three-way cock, which permitted fluid from the pump to be by-passed directly to the pump suction, thus giving neutral "gear"; or to be delivered and to drive the motors in either direction forward or reverse. The maximum pressure in the system appears to have been limited to about 800 lb. per square inch and the engine speed was 1000 r.p.m. It is not quite clear from the accounts of this exhibit how the four "gear" ratios, which were certainly available, were obtained. It is probable that the engine drove four pumps in parallel and that the control permitted the delivery of one, two, three, or all the pumps to be by-passed directly to suction, only that from those not by-passed going to the motors to propel the vehicle. Thus four "gear" ratios, dependent upon how many of the pumps were in action, would be obtained. It is, however, possible that there was only a single pump and that the motors were of the radial form—Fig. 5—with four concentric chambers. By admitting oil from the pump only to the innermost ring, the volume of which was small, a high "gear" could be obtained and lower "gears" could be engaged by successively opening the other rings to the ingoing fluid.

1927/254,473: *Mepstead*.[3]—The rotary piston machine with an ordinary reciprocating abutment has been tried on countless occasions since its first appearance at the end of the eighteenth century or earlier. The latest attempt to make it successful seems to have occurred in 1927, when the pump illustrated in Fig. 6 was put on the market by Mepstead and Co., of Willesden Green, London. As compared to its predecessors, this machine had a number of refinements. The more important concerned the abutment, which was made in two pieces. The delivery pressure was allowed to act between them and thus held them apart in tight contact with the guides. The rotary piston was rectangular in section and was mounted on a comparatively thin disc which ran between bosses projecting from the end covers. It was so shaped that its faces were tangential to the periphery of the disc and the abutment was lifted against spring pressure by the movement of the piston. Two pumping chambers seem usually to have been placed on the same shaft, the positions being set at 180 deg. This machine was apparently never constructed in large sizes. The pump described in THE ENGINEER had a nominal capacity of 2000 gallons per hour.

(To be continued)

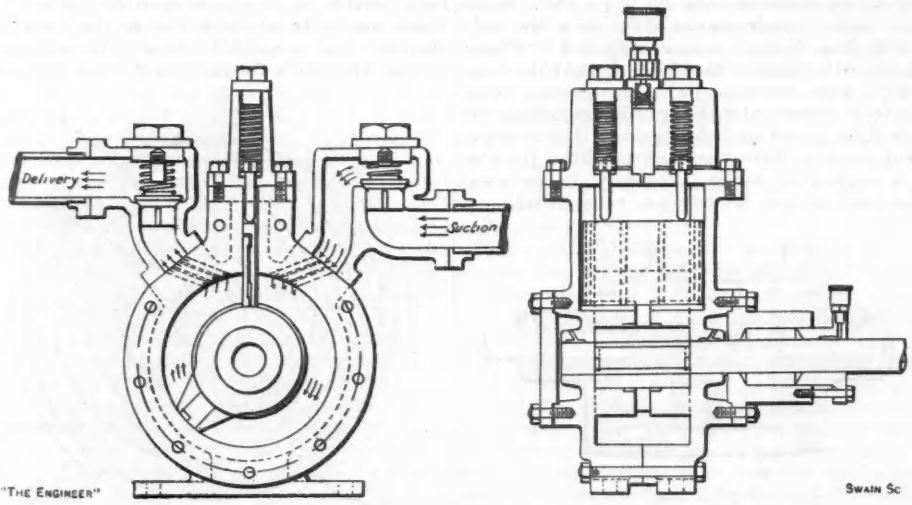


FIG. 6—MEPSTEAD—1927

A Day with Some Veteran Locomotives

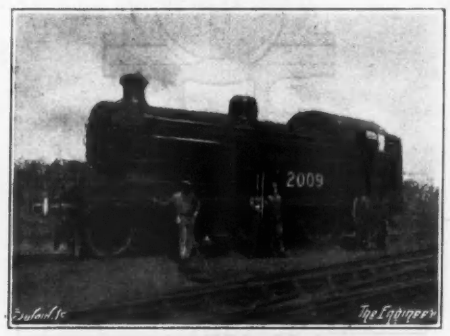
By EDWARD H. LIVESAY

THE articles that have so far appeared in THE ENGINEER dealing with my locomotive experiences have been concerned only with express engines, which naturally do work that is more spectacular than that of most other classes, and is more likely to merit description. But there are many other types of engines doing useful and equally necessary work, which, even if it is less striking, is nevertheless worthy of a little attention by anyone interested in locomotives and their performances. Tank engines are a case in point. Large numbers of these maids-of-all-work are daily going about their business in England, on branch and even main lines, giving essential service where it would be uneconomical to use bigger machines, but which service is apt to be unhonoured and unsung. It looked to me worth while, therefore, spending a day or two in their company, looking into what they were doing, as it did not appear quite fair that their more impressive associates should get all the kudos. My first day covered a number of interesting runs on several more or less ancient engines handling branch line trains. Thinking over what I had seen and noted, it seemed likely that others might care to hear about my experiences with these Cinderellas of the locomotive world, and this account is the outcome.

I chose the Southern Railway for my first trips, because not only has that company several classes of tank engines employed on varied and often quite heavy work, but, in addition, it serves the district in which my early days were largely spent, to which I have returned after years of expatriation, and where I learnt the interest in and, it is not too much to say, the affection for, locomotives that have only strengthened with time, and which I am not in the least likely ever to lose. I know the routes over which I planned to travel thoroughly; most of them, I am glad to say, remain almost unchanged in a changing world. Old memories and associations were revived, all the more vividly when I found myself, as I did, on the footplate of one class of engine that I had often seen then, which had actually begun running before I was even thought of. I felt I should enjoy myself in these familiar surroundings, and with these friendly old engines, and should be able to do better justice to both. Hence the choice of venue.

My first run was from London Bridge to Tunbridge Wells, through Croydon, Oxted, and East Grinstead, with the 10.45 a.m. train. It is an historical piece of line, and gives an engine plenty of scope to show what it can do in the way of rapid acceleration, hill climbing, and time keeping. Stops and curves are frequent, and the gradients over most of it fluctuate incessantly. The first 2¾ miles to New Cross Gate are level—it is only the Northern lines that immediately climb heavy banks out of their termini—over the great many-arched viaduct forming part of the old London and Greenwich Railway, built a century ago, one of the earliest pieces of English railway construction. Then comes the Forest Hill bank, 2¼ miles of 1 in 100, followed by 4 miles of nearly level going to a little south of Norwood Junction, where a rise of 1 in 264 begins, continuing through Croydon to where the route through Selsdon Road leaves the main Brighton line. To East Grinstead the profile is like the edge of a saw, and here a loop is taken, up into the high-level station, down through Forest Row, over a single line to Groombridge, and on into Tunbridge Wells West. The outlook changes as rapidly as the gradients; curvature is incessant and stations are close together. Out of London Bridge slums and factories predominate, followed by miles of suburban bricks and mortar, until at Sanderstead country is reached, the beauty of the North Downs, Surrey, and Sussex, almost defying the efforts of the builder to spoil it. As it was a perfect spring day, both environment and weather added to the enjoyment of the trip, and the severity of the route increased the interest of the work done.

The engine was "No. 2009," a 4–4–2 side tank, designed and built by Mr. D. E. Marsh in 1907, and rebuilt in 1929, at the Brighton Works. This class was the first of Mr. Marsh's designs for



TANK ENGINE NO. 2009

local traffic, and was very similar to engines running on the Great Northern Railway, from which company he had come. The leading bogie and the trailing truck make them suitable for safe running at fairly high speeds in either direction, and give them considerable coal and water capacity. The driving wheels are 5ft. 6in. in diameter, cylinders (inside) 17½in. by 26in., steam pressure 170 lb., and tractive effort 17,433 lb. The boiler is 4ft. 10in. in diameter, the total heating surface 1627 square feet, and the grate area 23·75 square feet. No superheater is provided, and the weight is 72 tons. These are the figures applying to the engines after rebuilding, as they are at present running. The Westinghouse brake was originally fitted to all the Brighton Company's engines, but after the railway amalgamation the vacuum system became standard, and though the familiar pump is still to be seen on "No. 2009," it is not used for train braking purposes, but only for the engine, to which a steam brake is not fitted.

The load was 150 tons, the train getting away from London Bridge at 10.46 a.m. There was no slipping, and the speed rose quite rapidly, until we were doing 40 m.p.h. before New Cross was passed at 10.52 a.m., and the steep 1 in 100 rise of the Forest Hill bank was begun. This was climbed with the regulator a little more than half open, and with 30 per cent. cut-off, the speed never falling below 30 m.p.h. The riding was very good. I have been on many engines, bigger, faster, and more impressive, to which "No. 2009" could give points in this. It was running bogie leading, but as the rigid coupled wheel base is short, and a radial truck takes care of the trailing end, easy action was to be expected.

Before New Cross was passed, I had already begun to feel sympathetic towards this old veteran, which was doing well, without any fuss or feathers. Over the bank, speed rose as Norwood Junction was closed; it was passed at 45–50 m.p.h., the switches and flyovers being taken with admirable

[2] We are informed by Dowding and Doll, Ltd., agents for Firma Pittler A.G., that there was no connection between the two concerns.

[3] THE ENGINEER, Vol. CXLIII, page 440; Patent No. 263,448.

steadiness, and we came to a stand in East Croydon at 11.01 a.m., where water was taken. The capacity in the side tanks and under the bunker is about 2000 gallons, and 3 tons of coal are carried. I had found the cab roomy and weatherproof, but the openings at the sides are large, and I should imagine that with a side wind there might be a good imitation of a cyclone on the footplate.

Leaving East Croydon at 11.07 a.m., 2 min. late, the gentle rise to South Croydon was begun, immediately after which the branch to Selsdon Road was taken, and at Sanderstead Driver Wheatley demonstrated what a smooth stop could be made by using the combination brake valve, which applied the Westinghouse brake on the engine and the vacuum brake on the train simultaneously. This kept the couplings between engine and train taut, and there was no tendency for the carriages to "bunch up" against the engine. As this braking system is a little out of the ordinary it merits description.

To enable the Westinghouse brake used on the engine to be worked with the vacuum ejector, the latter brake being used on the train, the "Jackson" combination valve is employed. It consists roughly of three piston heads of varying diameter on a common spindle. There are connections to the vacuum ejector, main reservoir, exhaust port of the triple valve, and an exhaust port to the atmosphere. The larger piston, 5in. in diameter, works in a vacuum chamber. The two other pistons are open to the pressure from the main reservoir, 90 lb. per square inch. When the brake is applied, the air pressure on the larger piston overcomes that on the smaller piston, and in the ensuing movement the exhaust port is closed, and a small spring-controlled valve is opened, allowing air from the main reservoir to pass through to the triple valve exhaust port, and into the brake cylinder. The brake pressure can be varied by equalising the pressure on either side of the pistons in the combination valve.

The "Jackson" valve is not used when the engine is running light, as only the Westinghouse brake is then in operation.

It is an interesting system, and seemed to work very well indeed.

At Sanderstead real country was reached, and how lovely this looked in its vivid green spring vestments! Riddlesdown tunnel was passed through, followed by stops at Warlingham and Woldingham. I began to realise the truth of what Wheatley had pointed out to me, that the work done on these local services by tank engines is far harder than appears at first sight. The timing is "tight," and the stops are so frequent that rapid acceleration is a *sine qua non*, all the more necessary as high speed between stations is impossible; they are so close together. All along this line the gradients see-saw up and down, curvature is the rule, and straights very much the exception. There is no time for day dreaming by either engine or crew—I hope the reader will forgive the mixed metaphor. The former needs skilful handling and the fireman must be on his toes, or incessant blowing-off at stations will be sure to occur. From Warlingham the country is really superlatively lovely, with high rolling hills, deep valleys, tree-studded; the embankments and cuttings are carpeted with primroses and bluebells, the fields like green velvet. Surely there can be no other country as lovely in its pleasant, homely beauty as this England. Certainly "one wanderer returned" found his attention continually distracted from engines to scenery by its irresistible appeal. Another long tunnel, under the chalk of the North Downs, and a pull up at Oxted, where again water was taken. On these engines, the boiler is fed by two pumps, driven off the crossheads, and by one live steam injector, the former doing all the replenishment generally needed, with the latter as a stand-by, for use when the engine is stationary or to check blowing-off.

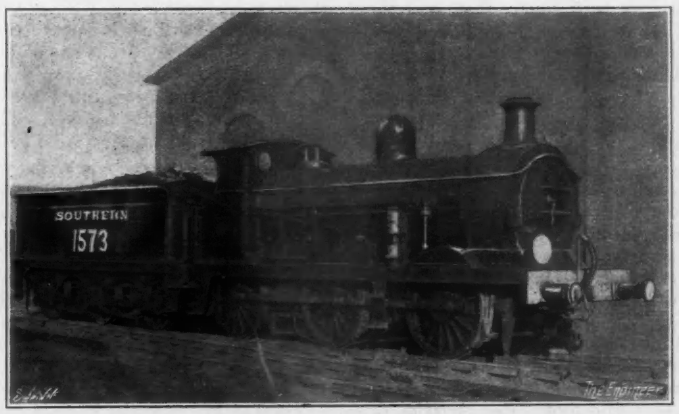
Oxted was left at 11.39 a.m., 1 min. late, for East Grinstead, and there were several more stops *en route*. I could not help noticing the good condition of the track, such a contrast to branch lines in Canada, where—providing the engine will as a rule stay on the metals—almost "anything goes." One long stretch was being relaid, yet really I could not see why. It seemed in excellent shape without it! I saw, too, that the long, narrow fire-box needed skilful firing. I was tempted to try my hand at it, but decided not to make my lack of skill too evident, and refrained. "Any old way" certainly does not do on these engines. I like to believe I could fire an "A 4"—that is, so long as my back held out, which would probably prove only a very fleeting period—but I have serious doubts as to my ability to satisfy a Southern "I 1/x." It was a relief, too, to see that there was no trouble from steam blowing down over the cab windows. The chimney was a chimney, and did what chimneys were originally intended to do—it carried the exhaust well clear of the cab, and the windows remained clean. Would that the same could be said of most modern express engines; but unfortunately it cannot, and hence "side plates," streamline fronts, and other eyesores, which do their best—sometimes—but are not always a complete solution of the problem in these days of long valve travel, short cut-offs, Kylchap blast pipes, and other draught-reducing nightmares. The "look ahead" was good, another blessing that nowadays is seldom found. It was possible to look through the right-hand window, past the shoulder of the smoke-box, and get quite a good view of the left side of the track. They used to be called "spectacle glasses" in the old days, I believe. A good name; modern engines suffer considerably from myopia. It was quite a novel experience to be able to see where I was going; I seem to have been taking a lot of chances lately.

"No. 2009's" valves were of the old "D" type, between and a little above the cylinders, at an inclined angle to the cylinder centre line, and were driven direct by Stephenson gear. Compressed air, provided by the Westinghouse pump, was called on to alter cut-off and reverse. Designers were evidently more considerate of enginemen's muscles in those days; sympathy was more plentiful, it would seem. Nowadays, men must be cheaper than mechanism, or perhaps money costs more. I cannot think of any other reason why power-operated reversing gear is not more used. The cut-off scale was not marked as finely as it is on modern engines; I almost had to use arithmetic to figure out what we were running on. Very short valve travel was evidently not indulged in when those engines were built. The driver was expected to be in sympathy with his engine and feel what it needed, or he would probably find the foreman was not in sympathy with him when his coal expenditure was investigated.

There is a by-pass from the blast pipe, part of the exhaust being used to heat the feed water, which must not be allowed to get too hot, as Fireman Francin pointed out to me, or neither pump nor injector would work. The 2000 gallons carried weigh over 8 tons, and I should think that if this were to be taken off the springs, as would be the case were it all used, some difference in the riding of the engine might be felt. On this trip it was never allowed to get very low, and I could not detect any alteration of running action.

East Grinstead—I wonder if there is another station in England with this unusual cruciform, high and low-level plan—was left at 12.11 p.m., 4 min. late, due to waiting the arrival of a connecting train on the low-level line. The railway then skirts part of the picturesque old town, sinking deeper and deeper into a rocky cutting, passing through two short tunnels out into the open, to begin a long, dead straight descent of 1 in 80 almost to Forest Row. This is a piece of track that, as a boy, I was very fond of, and which I used to haunt, to watch the trains from Horseshoe Bridge as they drifted down at 40 m.p.h., with steam nearly shut off, just as we were doing, to disappear round the bend into Forest Row. My thoughts went back as the train ran down this familiar stretch. There was Brambletye Castle. We had a fleeting glimpse of it through the trees, the old place which Cromwell took such a dislike to that he reduced it to its present condition. Or was it Cromwell? If not, some other iconoclast did; but I hope I shall be allowed to cherish my childish illusion. After Forest Row the pleasant Sussex countryside was threaded to Groombridge, where the single line ends, and thence into Tunbridge Wells West at 12.43 p.m., 1 min. early. The distance from London Bridge was nearly 43 miles, during which fourteen stops had been made. A most interesting, tightly timed run, which gave me a new respect for tank engines, and a clearer understanding of how much harder their work is apt to be than is generally realised.

"D" CLASS 0-4-2 TANK ENGINE No. 2244



"C" CLASS 0-6-0 GOODS ENGINE

In the neat, bright Tunbridge Wells shed I noticed what I have mentioned before—the cleanliness of Southern rolling stock and engine accommodation. The other railways might learn a lesson in this matter.

I left the Wells at 2.18 p.m. for Three Bridges *viâ* East Grinstead, on another engine of the same class, "No. 2001," with the diminutive load of three coaches, about 90 tons. The same lovely country was passed through, with the Medway, here only a brook, wandering beside the railway. The long Forest Row and East Grinstead incline, with its 1 in 80 gradient, was taken at 25–30 m.p.h., the light load naturally making it little of a task, and 50 per cent. cut-off with half regulator sufficed. At one point on a curve, I noticed a succession of studs between the rails, and was told that these were to indicate any shifting of the track, which was liable to occur there when the Medway goes on the rampage. East Grinstead was left at 2.59 p.m., ahead of time. From here to Three Bridges the country is of just the same peaceful beauty, with primroses and bluebells growing everywhere on the banks, and masses of trees bursting into vivid green. Nearing Grange Road there was a large bush, a mass of bloom, which looked like a rhododendron. Later, it turned out to be a tulip tree. As our American cousins have it, "this was a new one on me." Three Bridges was reached on time, 3.13 p.m., 20 miles from Tunbridge Wells, with seven intermediate stops. It is all these stops that play the mischief with speeds and punctuality, and which make this branch line work so much harder than it appears at first sight. The enginemen must know their work and route thoroughly to keep time, and Driver Foreman and Fireman Puckett evidently did so.

Three Bridges was a "turn around" point for

me, and meant changing to a totally different class of engine and train to any I have so far travelled with. It was an "Auto-train," push-and-pull combination, of three coaches, with a rebuilt Stroudley "D 1" 0–4–2 tank engine at one end, where it remains, irrespective of which direction the train may be running. As I looked it over, I thought what a contrast the trip was going to be from one I had made a few days before with the Pacific "Duchess of Hamilton" on the "Coronation Scot"! The "D 1" was nearly sixty years of age, built in 1881, doing useful work, when by all the rules of the game it ought to have been nothing but a memory. Yet here it was, still in the ring, confounding the prophets, looking capable of continuing to do so a good while longer. It brought to my mind the story of the architect who was gravely concerned about the safety of St. Paul's Cathedral. "When," he was asked, "according to your calculations, will it fall down?" "According to my calculations, it fell down eighteen months ago," was the reply. "No. 2244" must be something like St. Paul's. The probable explanation of its illogical longevity is that Stroudley built it. He used a simple design, good materials, and sound workmanship, so long life resulted. Every student of locomotive history knows what an influential part Stroudley played in the development of English engines. His was a name to conjure with.

"No. 2244" has the following dimensions:—The cylinders are 17in. by 24in.; driving wheels, 5ft. 6in.; and the boiler, which is 4ft. in diameter, has a heating surface of 943 square feet; the grate area is 15·5 square feet, and the boiler pressure 170 lb.; the weight is 43½ tons; there is no superheater, of course; 125 of these engines were built, doing a vast amount of most useful work in the London area and on branch lines.

As the train left Three Bridges, "No. 2244" was a "pusher," and as far as Rowfant, the first stop, I rode in the driver's compartment at the front, to see how it was driven. There were only four controls—regulator, train brake, whistle, and a "standby" hand brake, which only works on the driver's coach. Compressed air is the medium by which the mechanism on the engine is moved from the driver's compartment, among the advantages of which are comfort, weather protection, and a clear view of the track, made all the better by a window wiper. These should be on all engines, in my opinion. The fireman, in his isolation on the engine, looks after variation of valve travel and all matters directly concerning his usual duties. It was a good example of what a naval gunnery man would call "remote control."

Three Bridges was left at 3.48 p.m., and after noting how things looked from the driver's compartment, I transferred to the engine at the first stop. It was certainly the smallest footplate I have ever been on, but this had one advantage—almost anything in the cab could be reached without moving from one spot. The boiler supply was primitive. There were two pumps, worked off the crossheads, but no injector, so the engine had to be in motion before any water could be passed into the boiler. This must have resulted in some amusing situations, such as the water level getting low when the train was standing, in which case it would need to be uncoupled from the train and run up and down the track to fill the boiler. Fireman Fermor was a little apologetic about this, acknowledging that it had its drawbacks, and also that it was a nuisance to have no means of stopping blowing-off in a station other than by shutting the dampers, and opening the fire-door. The old veteran was running bunker first, but the riding was quite good. Naturally nothing hair-raising in the way of speed was done; probably 40 m.p.h. was the maximum down the long straight to Forest Row. The tulip tree, which I have already mentioned, came into the conversation as we passed it, Fermor saying that it did not bloom until forty years after planting. From this it would seem that considerable patience must be shown, with a strong expectation of life on the part of both planter and tree. However, I should say the result was probably worth waiting for in any case—it looked like an explosion of flowery glory.

"No. 2244" went no further than Forest Row, where the "turn around" filled in 40 min., pleasantly passed in "much argument about it and about," chiefly on locomotive subjects, the discussion at one period being made a little strenuous due to the engine joining in, and refusing to be shouted down by blowing off vigorously, the absence of an injector and lack of opportunity to run up and down the line preventing a stopper being clapped on this show of vim. Driver Pattenden made clear to me what a strenuous life this engine still led, age evidently not being regarded as sufficient excuse for treating her with any special consideration. On this particular day her duties meant over 150 miles running, between Lewes and Croydon, Tunbridge Wells and Three Bridges.

Forest Row was left "engine leading," which brought out the fact that room was at a premium on the footplate when the three of us were there. Again the long 1 in 80 climb to East Grinstead was attacked at about 25 m.p.h. At East Grinstead I left the energetic old relic, which disappeared round the loop in the direction of Croydon, boarding "No. 2009" again for the run back to Tunbridge Wells. For the fifth and last time I went spinning down the long straight to Forest Row, the engine running bunker first, which showed the riding in the reverse direction to be good; the speed was about 40 m.p.h. The footplate on this class is roomy, and side doors are fitted. The driver—I am sorry I have not got the names of this crew—was a much-travelled man. He had "persecuted his vocation" in Palestine and Mesopotamia during the war, and later, but he was decided in his opinion that, after all, England was best. "A place fit for heroes to live in"; we agreed that it was so, and that it explained why both of us had come back to it.

The return to London Bridge was made on another old engine, a class "C" 0–6–0 goods tender engine, "No. 1684," designed by Wainwright. It has had a long and useful career, beginning in 1900. The cylinders are 18½in. by 26in., driving wheels 5ft. 2in., the weight on them being 43 tons 16 cwt.; 16ft. 6in. front tube plate to back plate. The boiler is 11ft. 1$\frac{3}{16}$in. long between tube plates, with a total heating surface of 1200 square feet, and the fire-box has a grate area of 17·0 square feet. The steam pressure is 160 lb., and tractive force 19,520 lb.

Tunbridge Wells was left at 6.30 p.m. with a load of only 165 tons, a bagatelle to a goods engine such as this, but though the weight hauled was light, stops were frequent and timing fairly "tight," as is generally the case on such runs as this; again curves were frequent and gradients sharp. The direct route to Oxted was taken, *via* Ashurst and Edenbridge, and a lovely run it turned out to be, through a perfect spring evening of sunshine and lengthening shadows. The cab was of the old cut-away type, satisfactory enough for such weather as I was experiencing, but winter work must bring out its limitations. There was plenty of protection in front, and a little overhead, but none worth mentioning anywhere else. The riding was quite good, with little lurching or nosing; it was far better than I had looked for on a 0–6–0. The working of the reciprocating parts was unobtrusive. Smoke-box side plates were certainly not needed on this engine, the tall chimney and vigorous blast carrying all the products of combustion well clear of the cab. These old engines do not indulge in short cut-off running, with resulting dribbling exhausts, and there can seldom be any mistake as to what is happening at the front end. The shallow "D" valves are squeezed in between the cylinders, and probably steam ports and passages are constricted, so that the blast is very decided, even on quite moderate cut-offs. From the cab it all looks and sounds very impressive.

On this engine two live steam injectors are used, but no pump. The driver stood on the right, an awkward position from which to read signals; but on all the other engines I rode this day he worked from the left. I had no reason to complain of the seats on any of them, because there were none. This old goods engine had lockers, one on each side of the footplate, which could be used as seats, but they had drawbacks. There were no cushions on them for one thing, so they were harder and more galling than man's ingratitude, and so low that no look-out was possible from them. Also, when I tried the fireman's, I found my legs were being slowly roasted by rays from the fire-door. What with the draughts and the grit whirling in round the sides of the cut-away cab, plus the austerity of the furniture, conspicuous by its absence, I realised to the full what a stern old world these engines were built to take their place in.

East Croydon was reached on time at 7.42 p.m., after twelve stops had been made in the 27·26 miles from Tunbridge Wells. I wondered how Driver Dent could possibly judge his speed and the length of the many stops sufficiently closely to ensure punctual arrival, even though he had a working timetable to refer to. It must be quite a gift! And very easy to overlook a stop, especially when one may be necessary at a station on a certain day of the week, but not on another. This mistake had actually been made once by one of the four drivers I was with during the day. As told by him it was an amusing story. I will spare his blushes by not mentioning which one was guilty of this major driving crime.

In the "Flying Scotsman" article I mentioned the old Stirling steam reversing gear, suggesting it might be possible to revive it if mechanically operated gears ever came into favour again, and here I had an opportunity of watching it in use. It seemed quite simple and effective, and saved the driver considerable work. This system has two cylinders in tandem, one steam and the other containing oil on both sides of its piston. When the gear is put in motion, the admission of steam to the one cylinder simultaneously opens a transfer valve on the oil cylinder, allowing oil to pass from one end of the cylinder to the other as the piston moves along it. When the desired point of cut-off is reached, the shutting off of the steam is coincident with the closing of the oil by-pass, and the oil piston is locked in position by the fluid, together, of course, with the reversing rod. The valves on this class of engine are between the cylinders, actuated by Stephenson gear. It seemed an easy-steaming machine, Fireman Robson having no difficulty in keeping the safety valves near popping-off point; on occasion they gave evidence that he had misjudged things a little. They were of the Ramsbottom type.

Like many Southern men, Dent told me he handled both steam and electric trains. On asking him which he preferred, his answer was non-committal. He said he liked both, which is just as well on the Southern Railway, where both are found, though it rather disappointed me—I wanted him to say his inclinations were towards steamers.

East Croydon was left at 7.50 p.m., 2 min. late, which were being made up steadily, this old small-wheeled engine reaching about 50 m.p.h. down the Forest Hill bank, until a couple of signal checks through and after New Cross put us back again, and I saw we should fail to regain them. It had been an interesting day, and as we neared London Bridge, running over the twelve-track steam and electric congested approach, with the Dome of St. Paul's right ahead, silhouetted against the setting sun, I felt quite sorry it was over. We came to a stand in London Bridge at 8.8. p.m., still 2 min. late, but this was in no way the fault of either engine or crew, station work and signal checks being responsible.

I learnt several things from this pleasant excursion. That express services are not the only ones worthy of attention, nor "Pacific" engines of admiration—tank engines should come in for their meed of praise, too. That there are many veteran engines on the Southern Railway still running well, doing most creditable work, despite their years, and that they seem capable of lasting several years yet. That there is no definite "age limit" to locomotives where a Stroudley "D" is concerned; like the brook, they apparently go on for ever. That injectors are really useful on locomotives, and that you only realise how much so when you have not got them. And so on.

The reader will notice I always bring the enginemen into my stories, and I hope he will appreciate why I do so, and approve of it. Surely it is only their due; what would my experiences be worth without them? They would be like "Hamlet" without the Prince of Denmark. Lacking their goodwill and helpfulness, the runs would scarcely be worth making. I should miss much of interest which I try to pass on to my readers. I always find railwaymen easy to get along with, and have no difficulty whatever in adjusting myself to them. They invariably respond when sympathetic interest is shown in them and their work, which is, after all, generally the rule in most human relations—one gets what one gives. "Nothing for nothing, and devilish little for sixpence," says the cynic. Very likely, but cynicism gets one nowhere on a footplate, and friendliness does, as I have always found.

My thanks are due to Mr. Cobb, of the Southern Railway, for his courtesy in arranging the runs on which this article is based, and for correcting the proof of it.

WORKS POWER PLANT AT TIMPERLEY.—Since publishing our article last week on the Petter power plant installed at the Timperley works of the Wall Paper Manufacturers, Ltd., we have been advised that the belts used are not of the ordinary multi-vee type, but are of the jointed type and were supplied by the firm of James Dawson and Sons, Ltd., of Lincoln.

The Centenary Royal Show at Windsor

No. IV

(*Continued from page 69, July 21st*)

WE conclude in this article our descriptions of the agricultural implements and other engineering exhibits which were on view at the recent Centenary Show of the Royal Agricultural Society of England, which took place from July 4th to 8th in Windsor Great Park.

PETTERS, LTD.

The oil engines which were shown by Petters, Ltd., of Loughborough, included a full range of small air-cooled petrol engines and "Atomic" oil engines manufactured by the firm, many of which were shown as lighting sets for air-raid precaution and other work. This range of sets has now been extended to include units of from 1 kW to 5·5 kW. We show in Fig. 38 one of the

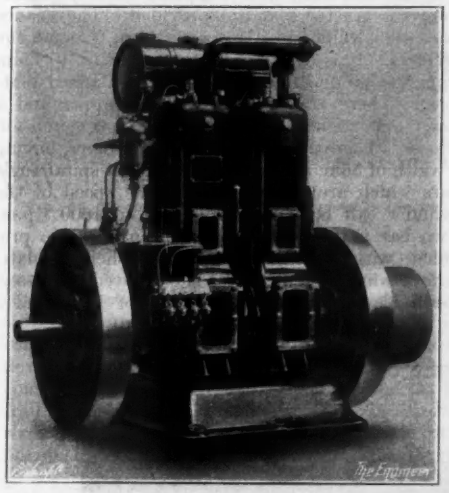


FIG. 38—TWIN-CYLINDER OIL ENGINE—PETTERS

larger of the "Atomic" oil engines which is a twin-cylinder unit with an output of 20 B.H.P. at 800 r.p.m. The cylinders have a bore of 4¾in. with a stroke of 6¼in., and work on the two-stroke, airless-injection principle, with a designed consumption of fuel of 0·40 to 0·45 pints per brake horse-power-hour. There are two fly-wheels and one belt pulley, the crankshaft being extended at both ends. The general symmetrical design of the cylinder heads and the cylinder casings may be noted, such a design having been chosen to allow for uniform expansion. Large inspection

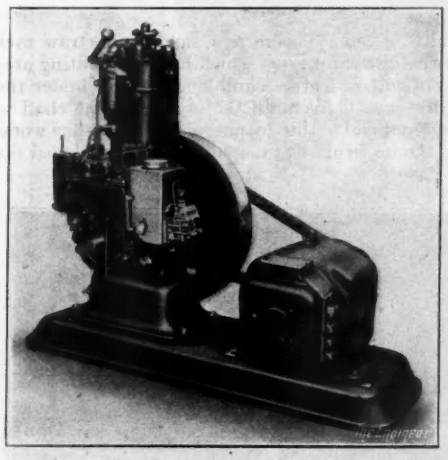


FIG. 39—GENERATING SET—PETTERS

doors give easy access to the water spaces. Special cast irons are used for the cylinder heads and pistons and heavy-duty roller bearings for the main bearings. The bottom end bearing of the connecting-rod is gun-metal with a white metal lining, the small end having a solid bush of "Carobronze." The fuel tank, as will be seen from our illustration, can be mounted behind the cylinders, and there is an easily cleaned fuel filter. The cooling is effected on the thermo-siphonic principle. Lubrication of the cylinder and the connecting-rod bearings is mechanical and the lubricator will be seen to the left of our engraving.

In Fig. 39 we show a single-cylinder unit of similar design which drives a 2·5-kW generator, mounted on a common base plate. Besides the engines referred to, several pumping sets were shown, and the portability of the small air-cooled petrol engine was demonstrated by a set mounted upon a pneumatic-tyred two-wheel trolley.

Another exhibit on the Petter stand was the Brush patented homogeniser made for the Improved Emulsification Process Company, Ltd., a subsidiary of the Brush Electrical Engineering Company, Ltd. The machine we illustrate in Fig. 40 is one of the two smallest of a range of thirteen machines with outputs from 25 up to 1000 gallons per hour, its output being 50 gallons per hour. The machines can be V-belt-driven from a drip-proof enclosed motor as shown, or can be arranged for a line shaft drive. With these machines it is possible to subdivide evenly the globules of the oil phase of an oil-in-water type

FIG. 40—HOMOGENISER—PETTERS

emulsion, to about 0·001 mm. in diameter, or from a tenth to a twentieth of the size of the original globules. This very fine subdivision is effected by a controlled series of operations. There are three rams set at 120 deg., and a pre-mixing is obtained in each barrel as the amount of liquid displaced is not equal to the full capacity of the cylinder barrel. Each of the three rams delivers to a common pressure chamber in the cylinder head in which a further mixing takes place. The mixed product is then forced by the pump through a very narrow aperture in the homogenising valve, thereby breaking up the globules of the oil phase to very small dimensions. The breaking up is further assisted by a correctly designed length of path along which the liquid is caused to travel, and an arrangement whereby a shearing force is caused by changing the direction of the globules through a right angle, at a high fluid velocity. The machine described is widely employed in the food and dairy and other industries.

ROADLESS TRACTION, LTD.

On the stand of Roadless Traction, Ltd., of Gunnersbury House, Hounslow, Middlesex, one of the noteworthy exhibits was a submersible lifeboat tractor specially designed for the Royal National Lifeboat Institution, and also supplied to the Noord-en Zuid-Hollandsche Redding-Maatschappij, of Holland. It has been developed from a similar machine used for agricultural and general contracting purposes, but has been modified in many ways. It is completely water-tight up to the height of the air intake, some 7ft. 6in. from ground level, as for launching the lifeboat it has to run submerged in the sea to a considerable depth, and has to operate at times over beaches incapable of carrying the weight of a man, and to haul a lifeboat on girder track units weighing with its carriage 11 tons.

A view of one of these tractors with a lifeboat on the beach is reproduced in Fig. 41. The general procedure is as follows:—The tractor hauling the lifeboat carriage on which the boat itself is mounted is brought along the beach to the spot intended for launching with the bow of the boat facing to the rear of the tractor. The tractor enters the sea to a depth of 3ft. or 4ft., and then turns so as to face the beach, and is uncoupled from the boat carriage, which it next pushes into the sea until a depth of 3ft. to 4ft. is again reached. From a launching platform in front of the tractor two ropes are then connected to it which are carried over pulleys at the far end of the carriage

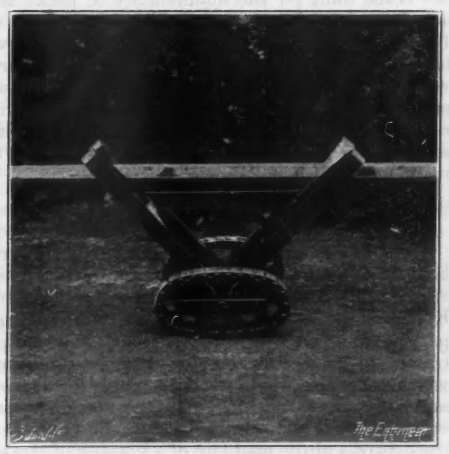


FIG. 42—LOG CARRIER—ROADLESS TRACTION

and brought back to the stern of the boat. The tractor is then reversed and as it proceeds up the beach the boat is propelled into the sea.

Such arduous work necessitated many alterations being made to the working parts of the tractor; they are either sealed or are connected up to the air intake pipe for the engine, which is 7ft. 6in. above ground level, as already mentioned. The sparking plugs, electric generator, magneto, &c., are housed in a closed aluminium casing placed high up on the off side of the engine and ventilated by passing through it the air required for combustion. For launching work a powerful searchlight is provided, as well as the usual electric self-starting equipment. Other special

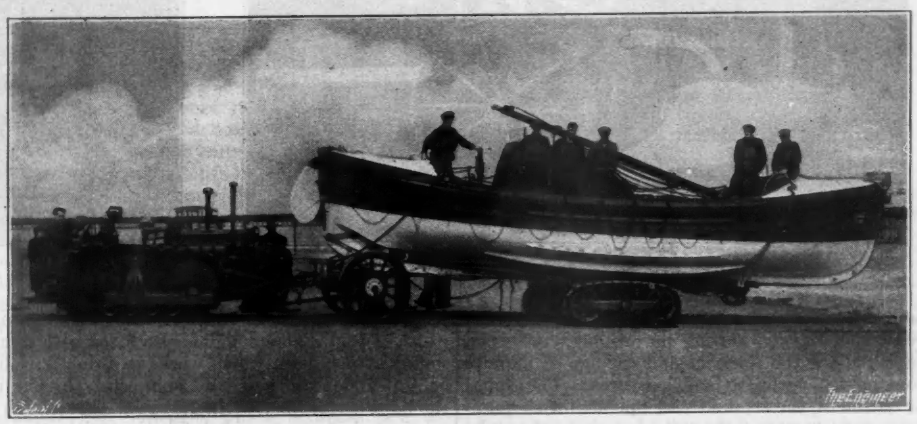


FIG. 41—LIFEBOAT TRACTOR—ROADLESS TRACTION

attachments include a differential lock, which can only be operated when the steering gear is in the locked position, and a bollard with a sprag-bar for use with it.

Several examples of the new "Orolo" track unit, which has been designed to carry heavy weights over difficult ground were shown. They are now made in capacities from 250 lb. up to 10 tons on a pair of units. Two carriers specially built for the transport of logs, bars, poles, and pipes are shown in Figs. 42 and 43, which illustrate the overslung and underslung types respectively. Other tractor exhibits included a half-track Fordson roadless unit, which was equipped with a jib crane, having a lift of 12ft. and a lifting capacity of 1 ton. This type of tractor is also supplied without

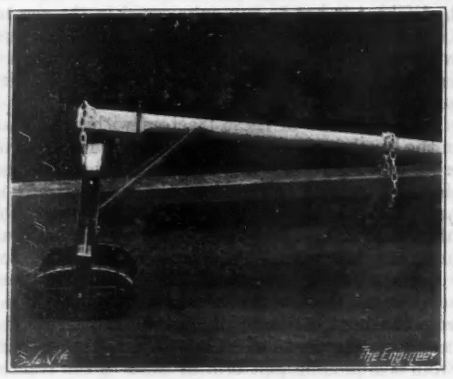


FIG. 43—LOG CARRIER—ROADLESS TRACTION

the crane unit, for the maintenance of parks and aerodromes, and is designed to haul up to 9 or 11-gang mowers. The Bristol tractor, which we have previously described, was also on view, and we noted that it is now available with either a two or four-cylinder Jowett engine, which increases its range of uses. A complete range of Ransome mowers and implements for use with this type of roadless tractor were shown.

KENNEDY AND KEMPE, LTD.

With the increasing number of pneumatic tyres now used with tractors for farm work, a special spiral strake has been designed by Kennedy and Kempe, Ltd., of Harewood Forest Works, Longparish, Andover, which, it is claimed, will allow a tractor to be usefully employed under conditions which otherwise would not be possible for a pneumatically tyred machine. As the accompanying engraving, Fig. 44, clearly shows, the equipment consists of a girdle made up of a number of strakes joined together by steel links. In the ends of the links there are excentric adjusters or washers, by means of which the length of the girdle can be shortened or lengthened when it is being attached to the rear wheel of the tractor. The strakes are generally fitted by laying the girdle flat on the ground and running the tractor on to it. The ends of the girdle are then lifted over the tyre and hooked together by the special couplings provided. A special tensioning tool is used to assist the joining of the ends. It is claimed that with these strakes a much higher efficiency can be obtained, when a tractor has to be worked on a loose top during sowing or rolling, or when employed for the removal and cartage of manure from sticky yards to soft pastures. The spiral formation of the strake tread operates with minimum disturbance of the soil or grass land, while, as the fitting is over the tyre, and not down the side of the wheel, a clean furrow is maintained when ploughing.

The same firm also showed a new form of grain dryer, which has been built to work with the small harvesters now available. The principle employed is to utilise an air blast to convey the

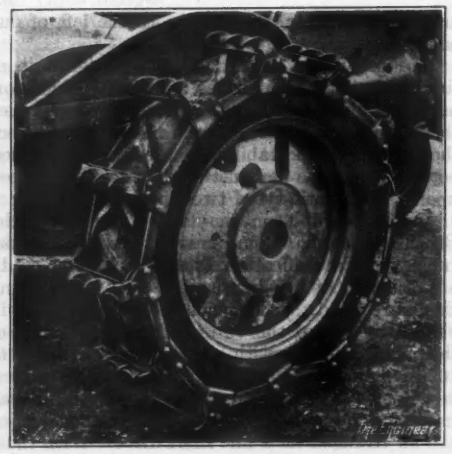


FIG. 44—SPIRAL STRAKES—KENNEDY AND KEMPE

grain, without employing mechanical conveyors or elevators. The incoming grain is distributed in several layers in parallel, thereby economising in space and utilising the air blast more efficiently.

BEDFORD PLOUGH AND ENGINEERING COMPANY, LTD.

From the wide selection of ploughs shown on the stand of the Bedford Plough and Engineering Company, Ltd., of Bedford, the successor to the engineering section of the late J. and F. Howard, Ltd., we have chosen two examples of new construction. In Fig. 46 we illustrate the new tractor plough named "The Giant," which has been designed to turn a single furrow to a depth of 15in. or 16in. and up to a width of 18in. The plough is also fitted with a subsoiling attachment, which works to a depth of 3in. or 4in. under the pan, and completely breaks up the hard surface below the furrow. This plough is particularly recommended for the cultivation of ground for deep-growing roots, such as beet, potatoes, mangolds, and other heavy crops.

The engraving reproduced in Fig. 47 shows the new "Hero" three-furrow semi-digging plough, which can be easily converted into a two-furrow plough and can also be fitted with general-purpose bodies. The beams of this plough are made from high-carbon steel and, as will be seen from our illustration, are well braced. The plough is designed to turn a furrow from 8in. to 10in. wide with a depth from 5in. to 9in. or 10in.

ALLIS-CHALMERS MANUFACTURING COMPANY

A new exhibit among the many examples of tractors and farm machinery which was to be seen on the stand of the Allis-Chalmers Manufacturing Company, of 728, Salisbury House, London Wall, E.C.2, was the new 40in. all-crop harvester, a view of which we give in Fig. 45. It has been designed to meet the needs of the smaller farmer and will deal with not only grain crops, but also those of beans and seeds. A new feature is the streamlined header of the machine, which forms an integral part of the machine and does not need to be removed either for transport or for storing. The reel has four arms and means for its adjustment from the tractor seat are provided. The header has a 40in. knife and it measures 45in. between the dividers. It is designed to cut from 2in. to 25in. from the ground and has a spring-balanced platform. There are two canvases, an upper and a lower one, with wood slats, and a spring tension release. There is a 15in. diameter cylinder, having a width of 36in. and consisting of eight spiral angle bars which are rubber faced. The speed of the cylinder can be varied from 425 to 1600 r.p.m. Two bar pattern rubber block concaves are provided, with an adjustable rubber shelling plate. A four-wing type of beater is employed with saw-tooth blades, having a diameter of 15in. and a

FIG. 45—TRACTOR-DRAWN HARVESTER—ALLIS-CHALMERS

width of 36in. There is a single-unit straw rack of the vibrating type, which has a separating area of 16 square feet. A full-length chain under the straw rack delivers all the grain and the chaff to the front end of the cleaning shoe. This shoe works on the underblast principle with a four-bladed fan having a diameter of 18in. The chaffers and sieves are adjustable and have an ample area. All the main drives are by V belts and all the more important high-speed shafts run in ball bearings. The grain bin has a capacity of 11 bushels and is fitted with a controllable delivery spout, which is conveniently arranged near the operator's seat and the

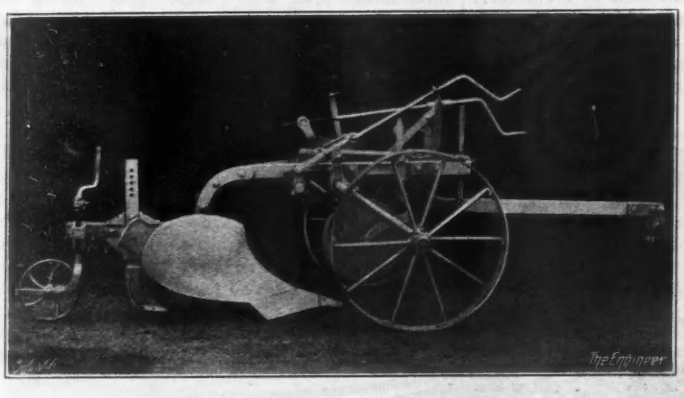


FIG. 46—SINGLE-FURROW PLOUGH—BEDFORD

FIG. 47—THREE-FURROW PLOUGH—BEDFORD

bagging platform. The harvester is mounted on pneumatic-tyred wheels. The principal dimensions of the machine are as follows :—Overall width, for cutting or transport, 7ft. 10in.; length from hitch to rear of body, 16ft. 3in.; height to the top of the body 5ft. 6½in.; height to the top of the elevator 7ft. 1in.; length of the body 8ft. 6in.; and tread 6ft. 10in. wide. As shown by our illustration, the harvester can be drawn by a single plough tractor.

A. C. BAMLETT, LTD.

A new type of self-lift tractor mowing machine was shown on the stand of A. C. Bamlett, Ltd., of Thirsk, and is illustrated in Fig. 48. It is made for both 5ft. and 6ft. cuts and it embodies the firm's

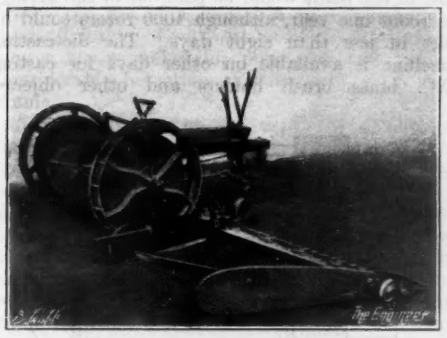


FIG. 48—TRACTOR MOWING MACHINE—BAMLETT

double drive with enclosed gears. All the working parts are lubricated from an oil tank which is combined with the steel tool-box and supplies oil to the inside shoe, the knife, knife slide, and the connecting-rod. A mechanically operated self-lift device is provided, and there is also a safety release coupling, which automatically disconnects the trailing mower should an obstruction be encountered. By means of a jack attachment it is possible for a driver to couple up to the tractor and to set the draw-bar at exactly the right height without help. The machine we have described is made for a right-hand cut only.

HARRISON MCGREGOR AND CO., LTD.

A prominent exhibit on the stand of Harrison McGregor and Co., Ltd., of Leigh, Lancashire, was the "Albion" corn drill, shown in Fig. 49 herewith. It has been designed to give perfect seeding with

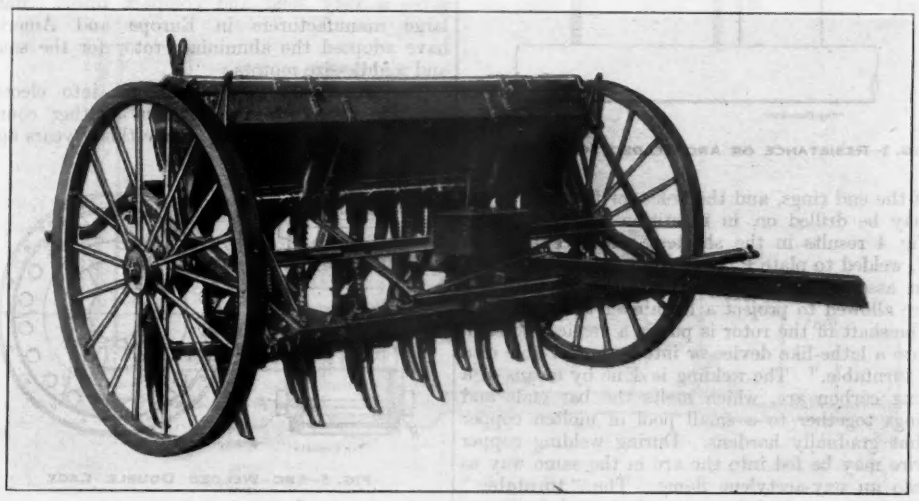


FIG. 49—CORN DRILL—HARRISON MCGREGOR

even sowing and an even depth. It is a thirteen row 6ft. 6½in. pitch, force feed type of drill with a 6in. pitch with the wheel in coulter, and at 6½in. pitch when running wheel in wheel. The sowing unit is adaptable for sowing most kinds of seeds, without damage, and consists of fluted rollers which, when revolving, carry the seed to the grain tube and thus to the coulter. Under each roller there is a spring-loaded feed plate, which can give to the seed, in order to avoid damaging it. The pressure on the plate is adjustable to suit the different seeds. The rate of sowing—that is, the quantity of seed—is regulated by an indicator lever on the rear of the hopper, which exposes the fluted rollers more or less to the seed. The rollers are spring loaded to take up wear, and the whole mechanism is so designed that there is no risk of the seed being crushed. The flow of the seed to each feed cup can be shut off by means of slides to suit narrowing widths of land, or when sowing seeds such as beet, turnip, &c., and the feed cup openings can be kept clear by means of an agitator in the hopper, which can be put in or out of gear at will.

Both the hopper and lid are of all-steel construction, with the exception of the guide blocks. The hopper is of large capacity, having 3 pecks per foot run approximately, and it is well braced to the frame. The lid can be quickly and easily removed, and when placed under the grain tubes

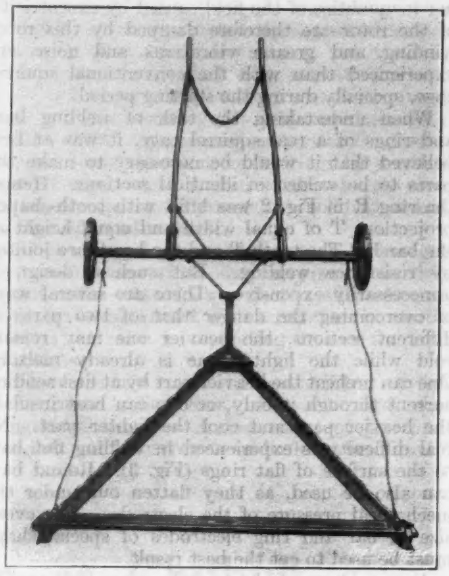


FIG. 50—THISTLE CUTTER—HARRISON MCGREGOR

can be used as a tray when emptying the hopper. The lid, when in this position, can also be used for testing the quantities to be sown before commencing work. Inside the lid are gauges to which the hoes can be set. The grain tubes are of spring steel ribbon which gives great flexibility.

The main frame is of specially rigid construction, and is made in the form of a rectangular angle iron straight frame, with full-length rear rail, gusset plates being fitted at each front corner and at the cross rails. The main axle helps to stiffen the frame, in that it does not revolve and it is clamped to the frame. Twist in the frame is eliminated by diagonal stays from the front of the frame to the seed box ends. With this type of frame the draught can be taken straight to the axle and frame. The lift lever is fixed on the rear rail of the main frame and controls the sowing mechanism automatically, the feeder wheels being put in or out of gear when the hoes are lowered or lifted. The lever also gives even lift or pressure on all coulters, and at the same time is so made that it can, by the removal of one bolt, be folded up for storing purposes. The whole machine is carried on substantial wheels, which are fitted with renewable bushes, staggered spokes, and wide tyres, giving a good support on soft ground, and efficient wheel scrapers are also supplied.

It may be noted that the lift rod, straps, and pressure springs are at the rear of the machine, a position which allows full pressure to be put on the coulters. The spring pressure is easily adjustable, and the coulters are fitted with a pin break for protection. The machine is normally fitted with pole and whippletrees, and two speeds for the feed mechanisms.

Another interesting exhibit was the "Universal" thistle cutter shown in Fig. 50. This implement can be drawn by tractor, car, horse, hay rake, float, &c., and it will do its work equally well at speeds varying from 2 to 10 m.p.h. The width of cut is 7ft. 6in., and when used behind a tractor or car 6 acres per hour can easily be cut, or when horse-drawn 2 acres per hour. As will be seen from our engraving, the cutting mechanism comprises two serrated high-quality tempered steel blades arranged in the form of a triangle coupled to a cross bar by means of a ball swivel attachment which is free to move in any direction.

The sideways movement of the implement, however, is constrained within reasonable limits by means of two guide cables which can be clearly seen in the engraving.

In order to suit varying types of land, the blades can be tilted higher or lower as the case may be, and it will be seen from the illustration that at the front end of the cutter there is an adjustment with thumb screws available for easy manipulation. For transport purposes the blades are collapsed to lie side by side, and the back cross bar which joins the blades together is swung into a parallel position to the blades, thus making a compact unit for transport or storage.

Sixty Years Ago

SIR WILLIAM COOKE

IT is doubtful whether the name of William Fothergill Cooke conveys much to the average modern reader. Yet writing in our issue of July 25th, 1879, soon after his death, we said that in the history of the electric telegraph his name would endure as long as would the names of Watt and Stephenson in the history of the steam engine. Cooke was born at Ealing in 1806. Following a "liberal education" and a period spent in the service of the East India Company, he returned to Europe and attended the lectures of Professor Möncke at Heidelberg. In March, 1836, Cooke was strongly impressed by the result of an experiment which showed that the electric current could be conveyed to a distance and caused to deflect magnetic needles. From that date onward he devoted himself "to the practical realisation of the electric telegraph." Within three weeks he had produced his first electric telegraph of the galvanometer form, using six wires for three circuits with three needles. He also invented at the same time a detector and an alarm. Six weeks later he was on his way to London with the drawings of a more perfect instrument. He became acquainted with Faraday and Dr. Roger, and was introduced to Wheatstone at King's College. Ultimately he and Wheatstone entered into partnership, but gradually Wheatstone began to claim the whole merit of the invention. Disputes arose and the assistance of arbitrators was sought. The arbitrators were Sir M. I. Brunel and Professor Daniell. In their award they gave Cooke the credit for being the person to whom the country was indebted for the practical introduction of the electric telegraph as a useful undertaking of national importance, but they also acknowledged Wheatstone for his profound and successful scientific researches on the subject. The united labours of these two gentlemen so well qualified for mutual assistance, had, the arbitrators said, been responsible for the rapid progress of the electric telegraph during the five years of their association. That verdict, we said, was the only conclusion which could justly be reached, and it was painful to find a man like Wheatstone with his own uncontroverted claims to recognition, steadily and persistently attempting to obtain renown at the expense of others.

AN INTERNATIONAL CONFERENCE ON FLAME AND FURNACES.—An international conference will be held in London in 1940 with the object of promoting discussion on the subject of flames, with special reference to their application to industrial furnaces. It has been convened by the Institute of Fuel and the organisation has been undertaken by the British Coal Utilisation Research Association. As drawn up at present the technical programme has been divided up into the seven following sections :—Slow combustion, pre-ignition and ignition phenomena ; flame and flame propagation ; combustion in polyphase systems ; heat transfer ; the furnace ; action of flame on materials ; and formation of flame. The programme will cover four days from September 17th to September 20th, and a number of visits will be arranged. All particulars are available from the Secretary of the Conference at 54, Victoria Street, London, S.W.1.

Indestructible Squirrel-Cage Rotors*

By Dr. E. ROSENBERG, M.I.E.E., M. Inst. Weld.

ROTORS are the most vulnerable part of squirrel-cage motors unless they are fireproof. This dictum may sound strange, considering that the stator insulation contains combustible material, while the rotor, as a rule, is built without insulation. But if the connection between rotor bars and rings is soldered or riveted, it will come to grief sooner than the stator winding. During the career of many a three-phase motor, the day comes when one phase is cut out, owing to the blowing of a fuse or to bad contact in one phase of the starter switch, be it an automatic or a hand switch. The motor may then fail to start, and both stator and rotor are subjected to high temperature. But the stator winding smokes before burning but, and in many cases smoke and smell may call the attention of a man in time to save

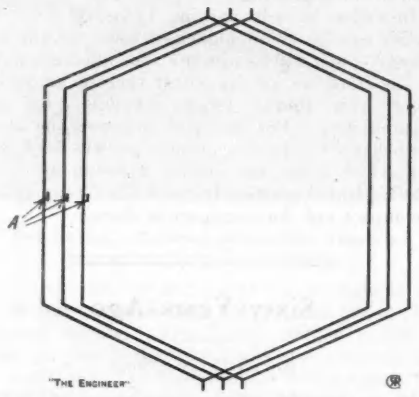


FIG. 1—INDIVIDUALLY SHORT-CIRCUITED COILS

the winding. With the rotor, however, the high temperature may have been sufficient to soften the solder or to deteriorate a riveted contact, and the motor then develops poor or irregular starting torque and deteriorates more and more in service, even if it is not entirely disabled at once. Experience has shown that a change from vulnerable to indestructible rotors reduces the repair bill of a large factory considerably, for stator failures are often only the result of rotor failures. Brazed rotor cages are satisfactory, but they are more expensive than welded cages.

A shop in possession of a portable transformer used for welding light copper sections, can weld a rotor winding that is composed of individual short circuited coils of diamond shape (Fig. 1). Several conductors can be placed in each slot side by side, and two on top of each other. The

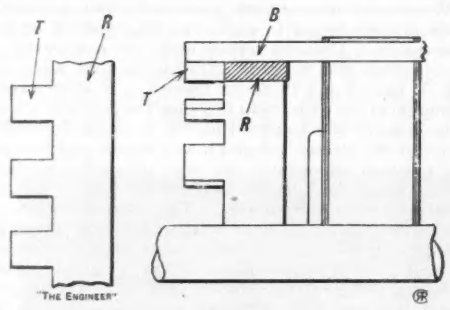


FIG. 2—RING WITH TOOTH-SHAPED PROJECTION

section of the conductor can be accommodated to the capacity of the welding transformer. The joints A can be placed inside the slot portion, preventing any danger, even in a shop employing men with little welding experience. Such rotors were made about thirty years ago. The construction proved satisfactory, but the design has several inherent disadvantages. The mean length of turn is very much greater than that of a proper cage winding, nearly double in the case of two-pole rotors. That means lower efficiency, lower power factor, and double slip, in spite of twice the amount of copper. The great advantage of the squirrel cage, *i.e.*, that it forms a short circuit for every pole pitch and can damp out the higher and lower harmonics, is missing. It would be an error to believe that the contact of the bare coils must give a similar effect. If the contact does not allow the safe passage of a large current with the very low voltage that can possibly exist between turns, owing to higher harmonics, it acts like insulation. Neither higher harmonics nor inequalities of the field caused by excentricity of the rotor are therefore damped by this rotor winding, and greater vibrations and noise are experienced than with the conventional squirrel cage, specially during the starting period.

When undertaking the task of welding bars and rings of a real squirrel cage, it was at first believed that it would be necessary to make the parts to be welded of identical sections. Hence, the ring R in Fig. 2 was built with tooth-shaped projections T of equal width and equal height as the bar B. The tooth T and the bar B are jointed by resistance welding. But such a design is unnecessarily expensive. There are several ways of overcoming the danger that of two parts of different sections, the heavier one may remain cold while the lighter one is already melting. One can preheat the heavier part by at first sending current through it only, or one can heat insulate the heavier part and cool the lighter part. No real difficulty is experienced in welding flat bars to the surface of flat rings (Fig. 3). Round bars can also be used, as they flatten out under the mechanical pressure of the electrodes. For every size of bar and ring electrodes of special shape must be used to get the best result.

Arc welding of bars and rings has proved entirely satisfactory and is a cheap method, even if no repetition work is concerned. The design of Fig. 3 lends itself without change to arc welding, but flat copper plates P (Fig. 4) may be used instead

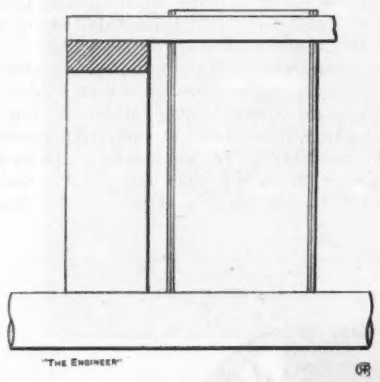


FIG. 3—RESISTANCE OR ARC-WELDED SQUIRREL-CAGE

of the end rings, and the holes for the round bars may be drilled or, in repetition work, punched. Fig. 4 results in the shortest rotor. Fan blades F, welded to plate P, keep rotor and stator cool. In assembling the rotor for welding, the bars are allowed to project a little over the end plate. The shaft of the rotor is put in a vertical position into a lathe-like device or into a central hole of a "turntable." The welding is done by means of a long carbon arc, which melts the bar ends and rings together to a small pool of molten copper that gradually hardens. During welding copper wire may be fed into the arc in the same way as into an oxy-acetylene flame. The "turntable" can be improvised by every shop, and facilitates the work, but is not necessary. With sufficient output, an automatic welding head pays. With small output, a hand welder with carbon electrode will also do satisfactory work. Many people do not realise what excellent work can be obtained with a carbon arc for the welding of copper.

For large double-cage rotors, starting under heavy load, a rigid connection of a single end plate with all the bars cannot be recommended. During starting, the thin bars near the rotor surface heat up, because they carry the bulk of the starting current, before the rotor has attained speed, while the heavy bars in the lower slots carry little current and remain cool. The end plates are kept rigidly in position by the heavy bars, and therefore the outer hot bars are prevented from expansion. In time this would result in failure, the thin bars breaking outside the plate, because the welded joint is stronger than the bar. To prevent failure, either the outer bars should be jointed to the end plate by means of curved pieces, or, better still, they should have their own ring r independent of the inner squirrel cage ring R (Fig. 5),

To the copper rings fan blades F of any material —for instance, steel—can be welded (Figs. 4 and 5).

A perfectly satisfactory design is the casting of aluminium cages done with a pressure die casting machine. In a factory producing a sufficient number of motors, it provides the cheapest rotor. A calculation showed that in a line of motors ranging from ½ H.P. to 15 H.P. an average of 4 per cent. of the motor price could be saved by adoption of the aluminium squirrel cage, and that with an output of 1000 motors a month the cost of the plant would be paid out of the savings in about one year, although 1000 rotors could be cast in less than eight days. The die-casting machine is available on other days for casting D.C. brass brush holders and other objects.

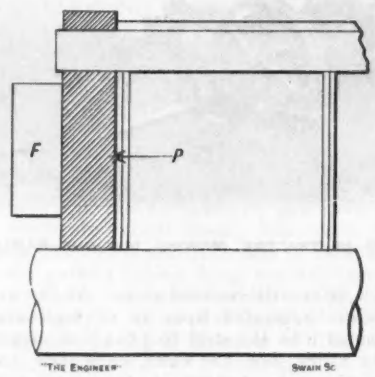


FIG. 4—ARC-WELDED CAGE

With greater production the initial outlay could be paid back in the course of a few months.

The idea that the results obtained with cast aluminium squirrel cages are not consistent, dates from old experiments, when, without special appliances, either the whole winding was cast or the end rings were cast on to aluminium wires. The fact that aluminium has 1·7 times the specific resistance of copper is offset by the freedom of shaping the slot and by its perfect filling with metal, which cannot be achieved by bars pushed into slots. With 1·7 times the section, the weight of the aluminium cage is half that of the copper cage. The contraction of the cage after casting gives a very solid and compact rotor. Many large manufacturers in Europe and America have adopted the aluminium rotor for the small and middle-size motors.

The introduction of aluminium into electric machine construction has taken another course than that once predicted. Some thirty years ago,

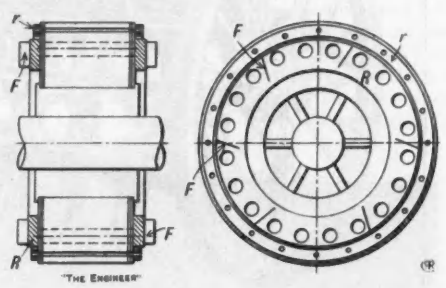


FIG. 5—ARC-WELDED DOUBLE CAGE

when the insulating quality of the aluminium oxide film was discovered, it was thought that insulated copper would be replaced by bare aluminium. This did not come to pass. Enamelled copper wire of the same outside diameter as bare aluminium wire has 1·6 times its conductivity, and the dielectric strength of the enamel covering is ten times as great as that of the oxide film. But just where the insulating film is of no importance at all, in squirrel cages, aluminium is displacing the copper.

A survey of indestructible squirrel-cage rotors would not be complete without reference to the solid iron cage without a winding. At first sight it would seem ideal, because the alternating flux and the current induced by it are penetrating deeper into a solid iron body with reduction of frequency. The resistance of the rotor circuit is therefore high at starting, when the rotor

* This article was occasioned by some remarks on rotors in Mr. N. F. T. Saunders' interesting paper on "The Design of Fractional Horse-power Induction Motors," presented to the I.E.E.

frequency is equal to the supply frequency, and is automatically reduced with increased speed. But there are disadvantages. At starting only a very small depth of the rotor iron is available for carrying the flux, the flux density is very high, and the power factor low. At full speed, with low rotor frequency, the current flowing below the rotor surface creates a great rotor leakage field, and therefore low power factor. Cast iron has five times the specific resistance of mild steel and two-thirds of its permeability, the depth of penetration works out three times as great. The penetration in mild steel does not exceed ½in. at 50 cycles, but is nearly ¾in. in cast iron. For 12 cycles the depth of penetration is double. Cast iron rotors, both on account of lower conductivity and deeper penetration, are worse than mild steel rotors. I have come across no case where the use of a cast iron rotor would have been advisable. Even with steel rotors, the poor power factor makes for poor efficiency and for considerable reduction of the output of a given frame.

The calculation of the depth of penetration is given in treatises on eddy currents in solid iron, the flow of current in solid iron conductors, and on eddy current brakes, which I published in *Electrotechnische Zeitschrift*, 1923, pages 513, 1055, and 1074. It was shown that the measured losses in all three cases are practically identical with those obtained from a "depth of penetration," along which the flux density remains constant, while the current density drops from a maximum on the surface to zero at the bottom of the depth of penetration, following a straight line law. While the core of a solid magnetic or electric conductor can be bored out with impunity underneath the depth of penetration, slotting from the outside has a very marked effect. The losses in the ends of a cylindrical armature, I measured as approximately half of those of the straight portion exposed to the primary field.

A Russian engineer, Cl. Schenfer (*Electrichestwo*, 1931, page 1360), suggested improving the solid steel rotor by cutting narrow deep slots into the surface, so increasing its surface, and pressing to the end of the iron core solid copper rings to reduce the losses in the end rings. B. Pljuchch reports that in this way a power factor of 0·85 was obtained with a four-pole, three-phase motor of 6 H.P. For larger motors he suggests laminated spiders. However, if one goes to the trouble of slots, copper rings, and even laminated spiders, there does not seem to be any object in stopping half way and omitting the conductor bars, which would allow of replacing an uncertain contact between iron body and copper rings by a reliable welded cage, which is also a great improvement in other respects. The use of a solid rotor body is then of no advantage.

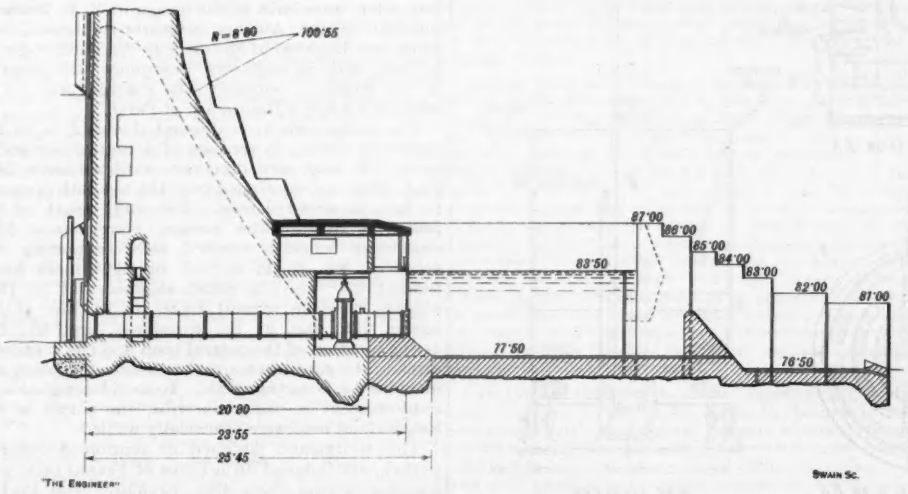
Solid steel rotors, without any frills, are good in certain cases where simplicity and ruggedness count more than power factor and efficiency. They have been used with advantage in starting motors and also in regulating motors for liquid rheostats.

There are cast steel rotors and others, cut from solid round rolled bars. In some cases short lengths of tubes or drums, rolled of ½in. plate, welded, and built on to a spider have been used.

Irrigation Dam at Chubuk

IN order to provide a regular and sufficient water supply to Ankara and the surrounding region, both for drinking purposes and for irrigation, the Turkish authorities have built a dam at Chubuk. This dam, illustrated on page 102, permits a maximum of up to 2970 million gallons of water to be stored.

Construction of the dam was decided upon at a point in the Chubuk River valley, about 12 kiloms. north of Ankara, where the valley narrows down between two points of rock. Construction at this point was found to be difficult, however, since an examination of the ground showed that the subjacent layers of rock were largely decomposed to a considerable depth. There were, moreover, a number of layers of pyrites in the rock, which created difficulties for the use of cement, which the pyrites can attack.



SECTION THROUGH CHUBUK DAM

The solution of the problem, reached after careful examination of the ground, was to clear away the surface rock and to reinforce the underlying material with injections of liquid cement. The depth to which the surface was removed depended entirely on local conditions, and varied from about 20 m. to 33 m. Injections of cement reached down to depths of about 25ft.

The next problem was to counteract the action of the veins of pyrites in the walls of the excavation. It was done by covering the walls of the excavation with a coating of a concrete mix containing 300 kilos. of cement per cubic metre of gravel, plus 4½ kilos. of "Aquasite." In this way there was provided a waterproof and sulphur-proof coating, which the pyrites cannot attack, and which protects the concrete of the dam foundations.

As an additional measure of safety, the foundations of the dam are made in concrete of the same characteristics, over which a layer of concrete in a mix containing trass has been laid. All the concrete of the base has been reinforced with iron rods. Laid on the base, and separating it from the body of the dam, is a waterproofing consisting of three layers of asphalt, each layer being separated from the other by a layer of felt. Only occasional expansion joints are provided in the base, as the temperature variations are relatively small.

The body of the dam, which had to be built for normal temperature variations of 60 deg. Cent., has expansion joints every 12 m. They are obtained by leaving expansion space between two perfectly flat walls of the dam units. Waterproofing at the joints is obtained by sheet copper, 2 m. wide, which is embedded in the concrete of the adjoining sections and closes the joint.

In order to permit an inspection of the joints, and to permit repairs to be made to them should this prove necessary at any time, an inspection flue, 1 m. square, is built with its centre line on the joint, and rising the full height of the dam.

Access to these flues is by a gallery at the bottom of the dam, 1·2 m. wide by 2 m. high. This gallery serves also to collect the water which seeps into the dam, and allows an inspection to be made of the extent and situation of the seepage.

A network of seep water drainage tubes has been built in, spaced 2 m. on centres horizontally and vertically, and built at 1·75 m. from the upstream face of the dam. Each of these tubes discharges independently into a canal in the floor of the inspection gallery. By watching the flow from these seep water drainage tubes, it is possible to localise the exact spot on the dam at which excessive seepage may be taking place. The tubes are made from precast concrete blocks, 1 cubic ft., pierced in the centre with a 4in. diameter hole. Made without sand, the blocks are particularly porous and permit water to seep in easily.

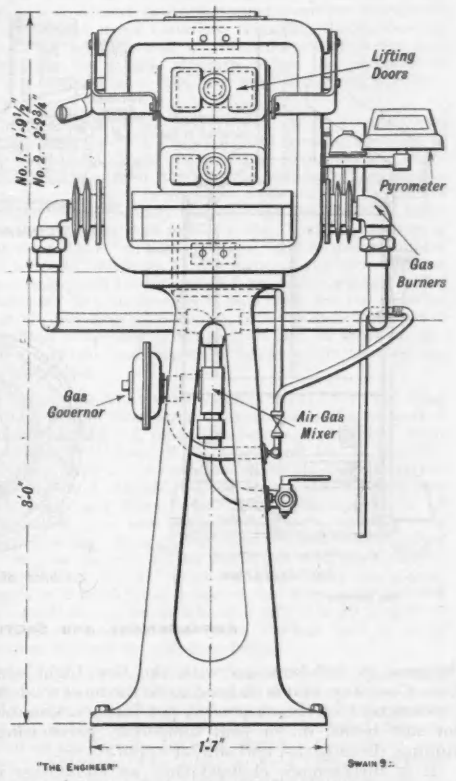
The upstream face of the dam is built perfectly vertical, while the downstream face is at an angle of approximately 53 deg. A gallery runs along the top of the wall, and permits visitors to walk along here. Overflow spillways are provided immediately above the old river bed in the valley. There are five overflow chutes, three of 6·62 m. clear width, and two of 8·2 m. clear width. Each of these is topped by a sluice gate which permits the level of the water in the reservoir to be raised slightly above the top of the chute, if this is desirable.

Apart from the chutes, the normal outlets of the dam, situated directly under the chutes, and also at one end of the dam, can care for a large proportion of normal flood water. The normal outlets feed to the river below the dam, on the one hand, and to irrigation canals running out from the dam on the other. The overflow chutes feed directly into the river. The sluice gates of both the chutes and the normal outlets are controlled by electric motors, with emergency control in case of breakdown, by hand.

In order to avoid the erosive action of the water from the chutes on the relatively soft river bed, the whole of the river is enclosed in a concrete canal below the dam for a distance sufficiently long to permit the turbulence introduced by the artificial waterfall to be absorbed.

Gas-Fired Furnaces

IN the accompanying engravings we illustrate two interesting gas-fired furnaces manufactured by Manchester Furnaces (1934), Ltd., of Globe Works, Ashton New Road, Manchester, 11. The drawing on this page shows the general arrangement



TOOL HARDENING FURNACE

of a tool-hardening furnace, designed at the industrial department of the Gas Light and Coke Company, at Watson House. The furnace has two chambers, an upper or preheating chamber, heated by the outgoing waste gases, to a temperature of 800 deg. Cent., and a lower hardening chamber, designed to be maintained at a temperature of 1350 deg. Cent. Two blast burners are fitted, one

REINFORCED CONCRETE BRIDGE OVER THE MARNE AT BRY

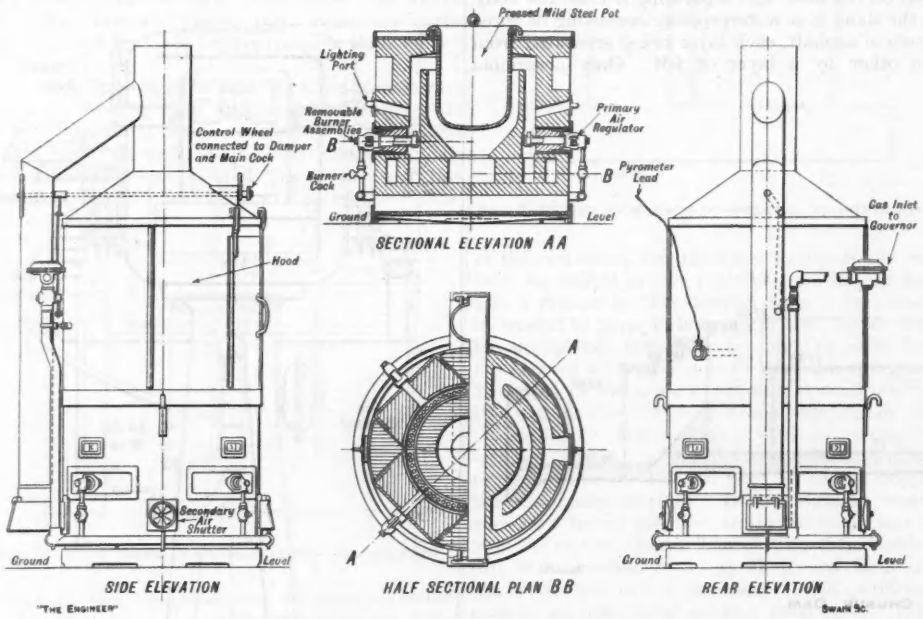
on each side, firing beneath the hearth of the high-temperature chamber, and by introducing a controlled supply of purging gas directly into this chamber the furnace atmosphere is maintained in the reducing condition necessary for successful hardening. Control of the burners is arranged through the action of a single proportioning valve in order to obtain automatic supply of the correct proportions of gas and air to the burners. A gas governor and a pressure gauge are mounted in convenient positions, and a pyrometer can be supplied, if required. This type of furnace is claimed to be particularly efficient and economical for hardening small carbon and high-speed steel dies and tools. It is supplied in two types, with working spaces 10in. by 6in. by 2½in. and 10in. by 6in. by 5in., respectively, as shown on the drawing.

The second furnace, which we describe herein and illustrate in the second engraving, has also been designed in collaboration with the Gas Light and Coke Company, and is claimed to be the most modern development of the suspended pot furnace, suitable for salt baths, oil or lead tempering, galvanising, tinning, dross baths, and similar applications.

It is furthermore claimed that an advantage is that the furnace can be applied to case hardening with the operating simplicity of cyanide hardening, but with important savings of time and working costs. We are informed that the case so obtained is of good quality and comparable with the best results obtained with box carburising. "Perliton" liquid carboniser is used, involving two materials, "Perliton" liquid heat, a yellow powder, and "Perliton" carbon, a hard grey-black compound in the form of small pellets. The process is described as follows:—The pot is filled with the "liquid heat" and the temperature raised to about 700 deg. Cent. to liquefy the salt. About 5 per cent. of "Perliton" carbon is added and the bath raised slowly to carburising temperature, say, 880 deg. to 900 deg. Cent. After saturation point has been reached the surplus carbon forms a crust on the surface of the bath, continuing energisation of the bath and conserving the heat. When withdrawing the work the crust is found to be brittle and easily broken. Only sufficient salt need be added each day to compensate for withdrawal losses, and the same bath can be used for reheating at 760 deg. to 780 deg. Cent. when required. It is claimed that the process gives a high quality of 0·9 per cent. carbon case with a gradual diffusion into the core, and that no possibility of embrittlement as the result of nitrogen or free cementite exists.

The arrangement is a suspended pot heated by flame from four quarter-circle perforated burners, the flaming gases being directed around and then below the pot by an annular wall of refractory material encircling the pot, the gases being finally led vertically downward to the flues. Adjacent to the flue chamber are ducts for the admission and control of secondary air preheated by contact with the walls of the flues. It is claimed that by avoiding localised flame contact with the base of the pot much longer life of this unit is obtained, together with freedom from cracking or bursting, while more even heating is ensured.

The furnace is built on a solid cast iron base and has interior refractory material backed by 3in. of insulation brick. The recuperator channels for preheating the secondary air are within the brickwork. Four natural-draught, heat-resisting steel burners are employed, complete with injectors, air regulators, and control cocks, each burner being housed in a moulded block of refractory-insulating material in an easily detachable casting bolted to the furnace casing. The furnace is provided with an aluminised solid pressed steel pot and is made in eight different sizes with inside dimensions of the pot ranging from 9in. diameter and 10in. deep to 18in. diameter and 24in. deep. The steel plate hood has double sliding doors and is of 16-gauge mild steel. To prevent the possibility of excessive oxidation of the pot a damper which is directly connected to the main gas cock is mounted in the products of combustion flue and is operated by one control wheel at the front of the furnace. This arrangement also allows for easy regulation of the temperature up to the maximum of 900 deg. to 950 deg. Cent.



ARRANGEMENT AND SECTIONS THROUGH POT FURNACE

Bridge over the Marne at Bry

IN order to replace an old lattice girder bridge over the River Marne at Bry, a reinforced concrete bridge has been built to the design of M. C. Bisdorff, engineer of the Ateliers Schwartz-Hautmont, and under the direction of Monsieur Le Vaillant, engineer in chief, and the engineers, Peyronnet and Gaspard, of the Highway Service. The contract was let to Ateliers Schwartz-Hautmont, of Paris.

The bridge, which is illustrated above, is of the cantilever type. It consists of a central suspended span, 72ft. long, carried on two cantilever arms, 79ft. long, which are continued over the towpath openings to form counter-balances. The total length of the bridge is 370ft. The decking comprises a 33ft. reinforced concrete vaulted slab supporting the roadway, 4in. thick, carried on eight main longitudinal ribs. The ribs, which are spaced at 7ft. 10in. centres, have an overall depth of 5ft. 3in. at the crown, 12ft. 6in. at the springings, and 6ft. 2in. at the junction of the central span and the cantilever arms. The cantilever arms are connected along the intrados by a curtain slab. To avoid congestion of reinforcement in the main ribs, the joints in the longitudinal bars were electrically welded.

The abutments, designed as reinforced concrete portals, are founded on a series of Franki piles with lengths varying from 43ft. to 56ft. The load is distributed on the piles through semi-hinges and a reinforced concrete raft.

The bridge was built in three stages. The three upstream ribs were first erected and a temporary roadway laid on them. Then the old bridge was dismantled and the five remaining ribs concreted and decked. Finally, the temporary roadway was removed and the decking completed.

High-grade cement being used on the contract and the concrete being vibrated, the compressive stresses of concrete were fixed at 1000 lb. per square inch.

In order to investigate thoroughly the distribution of stresses in the bridge, a reduced scale (1/100) model in xylonite was examined by the engineers of the Ponts and Chaussées Laboratory. Bending moments, normal and shearing stresses were found to be in agreement with the designers' calculations.

There was used on the contract 2900 cubic yards of concrete, 645 tons of steel, and 120,000 square feet of shuttering.

Rail and Road

ROAD ACCIDENTS.—During the month of June last there were 492 persons killed and 20,619 injured on the roads of this country. The respective figures for June, 1938, were 536 killed and 20,788 injured.

ANNUAL REPORT OF THE CHIEF INSPECTING OFFICER.—The annual report for 1938 of Lieut.-Colonel A. H. L. Mount, the Chief Inspecting Officer of Railways, shows that there were 717 accidents of all kinds to trains during the year. The casualties per million train miles were 0·7 killed and 18 injured.

NEW L.M.S. STATION.—In order to serve an important developing area, the London, Midland and Scottish Railway Company is to provide a new passenger station, to be known as Brindley Heath, adjacent to Moors Gorse level crossing, between Hednesford, Staffs, and Rugeley Town stations.

L.P.T.B. BILL.—The London Passenger Transport Board Bill has been considered by the House of Lords Committee on Unopposed Bills, and has been ordered to be reported for third reading. By the Bill powers are sought to run trolleybuses on short new routes in Camberwell, Southwark, and Kingston, to provide turning facilities for trolleybuses, and to make various tunnel improvements on the underground railways.

LONG SPAN CONCRETE BRIDGES ON C.N.R.—For some years past the Canadian National Railways has been making extensive use of precast and cast *in situ* concrete bridge deck slabs, which involves the use of continuous slabs up to over 112ft. long. These slabs are made up to 90ft. long for main line work and over this length for lighter suburban work. When this procedure is adopted, the tracks are laid directly on the slabs without sleepers or ballast.

AIR-CONDITIONED COACHES IN MALAYA.—In dealing with railways in a recent report on conditions in Malaya, Mr. R. B. Willmot says that in 1936 the Federated Malay States Railways placed orders in the United Kingdom for two special air-conditioned passenger coaches for use on the day mail train between Kuala Lumpur and Penang. This added amenity has been appreciated by the travelling public, and it is intended to extend the use of air-conditioned coaches to other sections of the line; air-conditioning equipment has, in fact, been ordered for eight passenger coaches which are being converted in the railway workshops.

NEW G.W.R. CARRIAGE DECORATION.—New standard colour schemes for the interior decoration of its carriages have just been adopted by the Great Western Railway Company. In first-class corridor compartments the colour scheme will be cream and blue; in first-class non-corridor compartments, cream and brown; and in third-class corridor and non-corridor compartments, cream and green. Curtains, blinds, carpets, and linoleum will match the patterned upholstery, while the woodwork will be in polished teak. All new coaches built at Swindon will incorporate the new colour schemes, and a start has already been made on some of the coaches passing through the shops for repair.

OIL LUBRICATION OF LOCOMOTIVE JOURNALS.—In a report on the meetings of the Mechanical Division of the Association of American Railroads, the *Railway Age* deals in some detail with the report of the Committee on Lubrication of Cars and Locomotives. It states that the replies to a questionnaire showed an increasing tendency to substitute oil lubrication of driving journals in place of grease. A new development now under test incorporates a floating axle flooded in oil by a pump actuated from the movement of the locomotive and running in a bronze bushing, and a lateral device consisting of a collar forged into the centre of the axle to which wear-resisting plates are opposed, and, like the journal bearing, flooded in oil. This, in effect, is a full floating axle. In view of the interest indicated in the application of oil lubrication to locomotive driving journals, this device is considered to hold interesting possibilities, although to date tests have not progressed sufficiently to indicate the ultimate results that may be obtained.

NOISE LIMIT FOR MOTOR HORNS.—An agreement has just been reached between the Minister of Transport and manufacturers of motor horns to limit in future the noise output of horns fitted to motor vehicles. Negotiations between the Ministry and the Society of Motor Manufacturers and Traders, representing manufacturers of motor vehicles and accessories, have now resulted in the Society giving an undertaking to the Minister that after October 1st next manufacturers of motor horns will not offer for sale instruments with a loudness under specified conditions of test exceeding 100 phons, except in the case of the wind-driven type of instrument, for which the figure is to be 105 phons. Vehicle manufacturers have agreed to co-operate by fitting only horns which comply with the agreed standard to new vehicles manufactured by them. This action is a result of the recommendations made in the final report of the Departmental Committee on Noise in the Operation of Mechanically Propelled Vehicles.

RAILWAYS IN SWEDEN.—A recent report on the economic and social conditions in Sweden by Mr. H. A. N. Bluett, states that during 1938 the length of State-operated railways increased from 7679 kiloms. to 8031 kiloms., whilst the length of privately owned lines decreased from 9095 kiloms. to 8849 kiloms. It is pointed out that in March last a Bill was introduced into the Riksdag containing "measures for the unification of the Swedish railway system." It proposes that all the privately owned railways should be nationalised on a "voluntary" basis, but, as a precaution, a law to enable the Government to expropriate private railways has also been drafted. The total cost of the scheme is estimated at approximately 330 million kronor, to be defrayed in the course of five years. A considerable part of this sum, namely, about 180 million kronor, represents State liability for the payment of the debts of the railway companies, which, largely owing to competition from road services, are for the most part in a strained financial position. The Bill is based on the reports, submitted in October, 1938, of the Railway Committee of 1936.

Miscellanea

RUBBER IN CHEMICAL ENGINEERING.—The British Rubber Publicity Association has just issued the second edition of its handbook, "Rubber in Chemical Engineering."

LARGE BLAST-FURNACE.—What is stated to be the largest blast-furnace in Britain was recently put in service at the works of the Appleby-Frodingham Steel Company, Ltd., Scunthorpe. The new furnace is 200ft. high and is capable of producing 3500 tons of pig iron a week. A second similar furnace is to be placed in commission shortly.

TALL POWER STATION CHIMNEY.—What is said will be the tallest brick chimney built in this country is to be constructed at the new Hams Hall power station at Birmingham. It will be 400ft. from the top to ground level and have foundations about 27ft. deep. At the top the internal diameter will be 22ft. The contract price for the chimney, which is to be built by P. C. Richardson and Co., Ltd., is stated to be £26,000.

PROPOSED ACCELERATED TELEGRAPH SERVICE.—In order to accelerate the sending of telegrams the General Post Office is to arrange a system of automatic switching between the teleprinter offices. When introduced there will be direct dialling connection between all the units in the teleprinter network and it is expected that it will be possible to send a telegram from one end of the country to the other in a few minutes.

SILVER-LINED CONTAINERS.—According to the *Chemical Trade Journal and Chemical Engineer*, the American Silver Producers' Research Project has been extended for a further year. It has been decided to concentrate attention during this final year on work relating to the commercialisation of silver-lined containers, silver alloys, electrical brushes, fungicides containing silver, and corrosion studies. The research connected with the container and alloy programmes is concentrated at the Bureau of Standards. A silver-plating plant has been set up and will be used to prepare material for fabrication by commercial organisations which are co-operating with the Project in its effort to develop silver-lined containers.

SMALL STEAM GENERATORS.—An interesting little steam generator has been added to the range of products of the Westinghouse Electric and Manufacturing Company of the United States. It is designed for the rapid production of small amounts of superheated steam, such as might be required in laboratories, clinics, surgeries, &c. The generator comprises a transparent cylindrical case, most of the interior of which is occupied by an insulating core wound with resistance wire. At the top end is a pipe comprising the steam outlet and at the bottom are terminals for connecting to a 105–125-volt circuit. The cylinder contains about 5 oz. of water and it is claimed that steam can be superheated to 350 deg. Fah. from cold water in less than fifteen seconds.

CRACKED CYLINDER HEADS.—In a paper on oil engine locomotive operation, given by Mr. H. H. Urbach before the Association of American Railroads, the author said his company had experienced considerable trouble with cylinder heads cracking across the valve bridge. Investigations showed that the failures were caused by an air-bound condition in the water cooling system. In one instance it was found that the air compressor head had a leaky gasket. This air was trapped in the cylinder head, creating a steam-bound condition with the resultant overheating and cracking of the valve bridge. The air-bound condition was eliminated by the application of ¼in. copper tubing, which exhausted to the atmosphere any air in the water cooling system. Since the introduction of this tube very little trouble had been experienced with cracked heads.

BRITISH FOUNDRY SCHOOL.—The fourth annual report of the British Foundry School, Birmingham, concludes as follows:—"The continued growth and development of the industry, its importance in national defence, and the acute shortage of properly trained executives in the industry, confirm the governing body in their view of the value of the School to the industry, and they urge responsible firms in the industry to consider nominating suitable men to take the course, or, if such men are not available, to establish a scheme of apprenticeship which will attract men of proper calibre, the concluding years of which should be spent at the School. A suitable basis for such apprenticeship is given in an appendix. It must be emphasised that since the large majority of students are nominated by their employers, to whom they naturally return, students leaving the School are not normally available for other employment."

LAPLAND ELECTRIC POWER TO DENMARK.—By the connection recently at Nässjö, in South Sweden, of the South and North and Central Swedish electrical power networks, one of the world's longest electricity transmission systems has been set in operation. This connection has been made possible by the recent completion of a 200-mile transmission line from Horndal, in Central Sweden, to the town of Nässjö, in the south of the country. As the South Swedish power system also, to a certain extent, delivers electricity to Denmark by submarine cable across the Sound, electric power generated by the large plants in the Swedish subarctic regions will now be transmitted as far southwards as Copenhagen. The total length of the line from the most northerly of the Swedish power stations, the Porjus plant in Lapland, to the Danish capital, is about 1000 miles. For the greater part of the distance the current is transmitted at 220,000 volts. The purpose behind the construction of this long transmission system is to obtain a more even seasonal distribution. In Northern Sweden the melting of the snows proceeds until far into the summer, at which time the South Sweden rivers are at low water, and when winter comes to freeze the watercourses in the north, the autumn rains usually commence in the south. Work is at present being prosecuted on three new plants of fairly large size by the Swedish Board of Waterfalls, two of them in North Sweden of respectively 65,000 kW and 80,000 kW, and one of 100,000 kW at Trollhätten, the large power production centre near Gothenburg.

Air and Water

SCAPA FLOW SALVAGE WORK.—The German 26,700-ton warship "Derrflinger" has been brought to the surface at Scapa Flow from a depth of 26 fathoms. It has been announced that no more of the scuttled German warships are to be salved, and Scapa Flow is to become a full naval base.

CALIFORNIAN AERONAUTICAL RESEARCH STATION.—Colonel Lindbergh, giving evidence before the Appropriations Sub-Committee of the House of Representatives in Washington, recommended the immediate establishment in California of an aeronautical research station, costing more than £2,000,000, to supplement that which is already established in Virginia.

VANCOUVER AIRPORT.—An improvement programme costing about 107,000 dollars, has been begun at Vancouver airport. Most of the money will be spent on the construction of a new main runway, 150ft. wide and 3300ft. long, some 100ft. from the existing runway. It is hoped that it will be possible later to fill in the space between the two runways to make one 300ft. wide.

FIRST FLIGHT OF THE "GOLDEN HIND."—On Saturday, July 22nd, the "Golden Hind," the first of the Imperial Airways three new 31-ton flying boats, was flown for the first time over the Medway at Rochester. This machine, with its four Bristol "Hercules" engines, each of which has a take-off rating of 1380 H.P., has a maximum range of 6000 miles and a cruising speed of between 180 and 190 miles an hour. It will shortly be flown to Felixstowe for tests for a certificate of airworthiness.

TWO NEW L.M.S. STEAMERS.—The London Midland and Scottish Railway Company announces the placing of an order with the Fairfield Shipbuilding and Engineering Company, Govan, for two fast twin-screw turbine steamers for the Holyhead and Kingstown (Dun Laoghaire) service. These new steamers, which it is expected will be placed on the service in 1941, will be driven by single-reduction geared turbines. They will have a length of 390ft. between perpendiculars and a beam of 54ft., and will be capable of carrying 2000 passengers each: 750 first-class and 1250 third-class.

PROPOSED NEW LINERS FOR THE CANADIAN–AUSTRALIAN LINE.—Sir Edward Beatty recently stated that with regard to the construction of the proposed two new liners for the Canadian–Australian Line, it would not be economic for the companies to build at the present high prices. The replacement of the older "Orient Empresses" and the "Empress of Australia" would be deferred, and the present vessels would be reconditioned for continuation in the services. He also said that it was hoped that within the next year or two world conditions might be sufficiently stabilised to justify the expenditure of the large amount which would be involved in the construction of modern liners.

FATIGUE OF METALS IN AIRCRAFT.—In an article on fatigue problems in the aircraft industry, in *Metals and Alloys*, Messrs. K. Arnstein and E. L. Shaw, of the Goodyear-Zeppelin Corporation, say that fatigue does not seem to have been an important cause of aircraft failure in the past. No fatigue failure of a primary structural part is known to the authors, who say that higher speeds and new materials, particularly with increasing ratio of static to fatigue strength, are introducing new problems. They conclude that more knowledge must therefore be acquired of the actual stress variations occurring throughout the life of an aircraft, and of the influence of design and fabrication on fatigue strength before the problems of future development can be met with complete confidence.

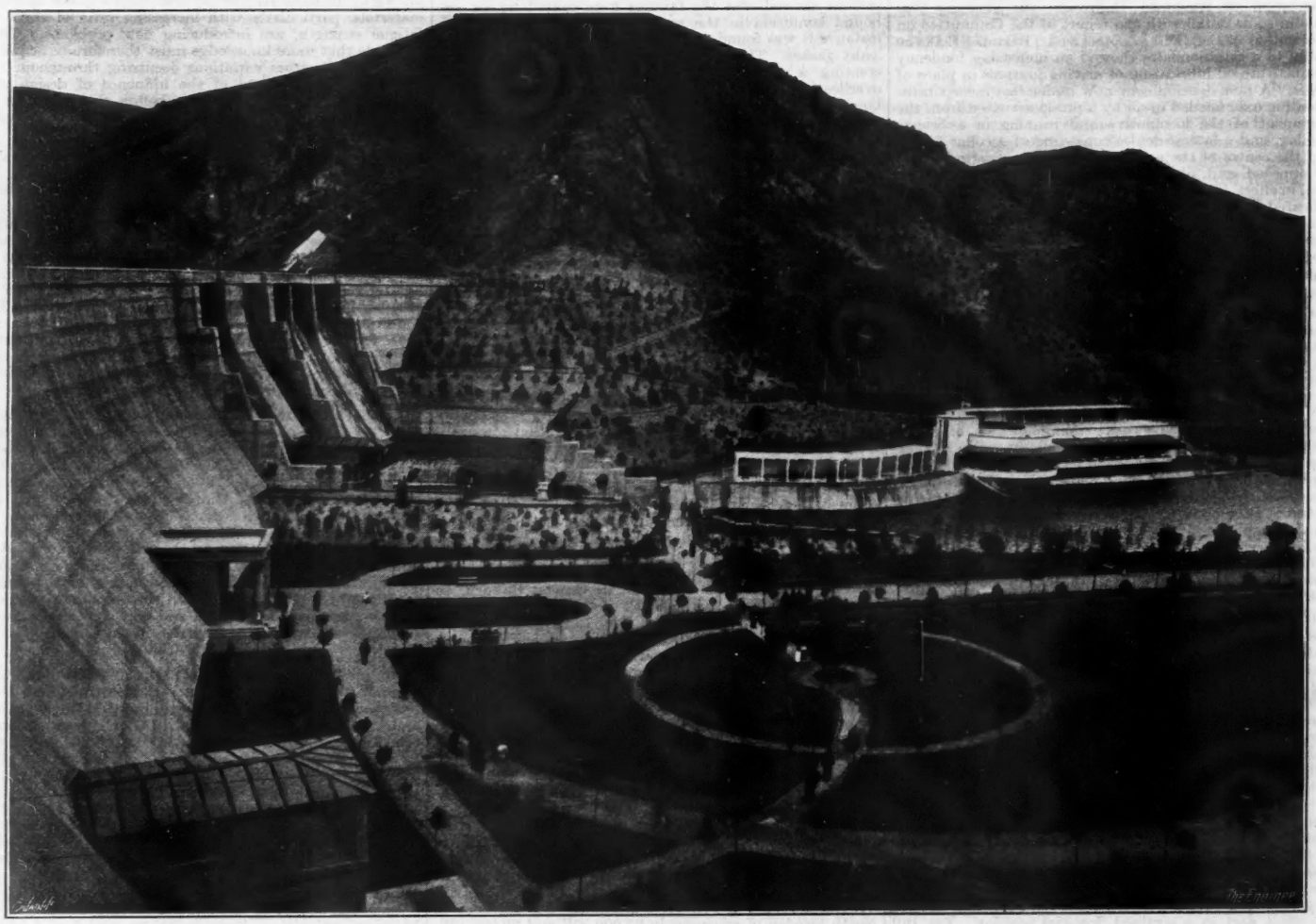
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—A recent special general meeting of the North-East Coast Institution of Engineers and Shipbuilders, a resolution altering the articles of association in such a manner as to introduce a new class of "graduate member," was formally passed. As the result of these alterations, what was formerly the Graduate Section is now termed the "Student Section," and former graduates are termed "students." Members of the new class of membership will be designated "graduate member." The conditions for membership of this class are the same as those for associate membership, with the exception that it is limited to persons of between 25 and 35 years of age. The conditions and privileges of associate membership are unchanged.

PLASTICS IN AIRCRAFT CONSTRUCTION.—A recent issue of the *Scientific American* gives particulars of a method of making aircraft of plastic materials, which has been developed by Colonel V. E. Clark and Dr. L. Hendrik Baekland, with the co-operation of the Haskelite Corporation, of Grand Rapids, United States. A machine has been made and flown which has a fuselage made of "Duramold," a new laminated plastic incorporating phenolic resins. It is claimed that the new material does not chip or corrode, resists water, oil, and acids, and is stronger than metal. In the description of the manufacture of a fuselage, it is stated that nine men moulded the complete member in 2 h., and only 5 h. 20 min. were required to assemble the entire fuselage and fit it in position, without any filing or drilling.

FLYING BOAT FOR PILOTS' TRAINING.—The flying boat "Maia," the lower component of the Short-Mayo composite aircraft, has become a training ship for air pilots, and she is now at the disposal of the Imperial Airways school at the Empire air base, Hythe. This school prepares junior pilots, now acting as First Officers, for their full captaincies. "Maia" will be the first flying boat in Great Britain to be used as an aerial class-room for pilots seeking their first-class navigators' certificates. Though new equipment has been installed in the flying boat for instructional purposes, "Maia" will still be available, when required, as the lower unit of the Short-Mayo composite aircraft. She will also be used for testing new instruments for the Imperial Airways flying boat fleet. "Maia" is similar to the standard flying boats. She is, however, stripped of interior fittings, and has a special pylon structure on her wing to which the seaplane "Mercury" is attached for mid-air launching.

IRRIGATION DAM AT CHUBUK, TURKEY

(*For description see page 99*)



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Contents

THE ENGINEER, July 28th, 1939. PAGE

A SEVEN-DAY JOURNAL ... 89

LEADING ARTICLES—
THE HATED AEROPLANE ... 103
CONTROLLED PRICES ... 103

SPECIAL ARTICLES—
CENTENARY ROYAL SHOW AT WINDSOR. No. IV. (Illus.) 95
DAY WITH SOME VETERAN LOCOMOTIVES. (Illus.) ... 92
ELECTRICAL STAMPINGS WORKS. (Illus.) ... 105
HISTORY OF ROTARY ENGINES AND PUMPS. PART II: No. I. (Illus.) ... 90
INDESTRUCTIBLE SQUIRREL-CAGE ROTORS. (Illus.) ... 98
IRRIGATION DAM AT CHUBUK. (Illus.) ... 99

BRIDGE OVER THE MARNE AT BRY. (Illus.) ... 100
DISTURBING FORCES IN A LOCOMOTIVE. No. II ... 106
FANS FOR A.R.P. (Illus.) ... 109
GAS-FIRED FURNACES. (Illus.) ... 99
NEW BOILER PLANT AT DALMARNOCK POWER STATION. No. II. (Illus.) ... 110
READY MIXED CONCRETE. (Illus.) ... 108
RAILWAY RATES TRIBUNAL REVIEW ... 104
TYNE IMPROVEMENT SCHEME ... 112

LETTERS TO THE EDITOR—
THE NEW CONCEPTION OF BUSINESS ... 104

LITERATURE—
BOOKS RECEIVED ... 104

OBITUARY—
JOHN MACKWORTH WOOD ... 104

NEWS AND NOTES—
AIR AND WATER ... 101
AMERICAN ENGINEERING NEWS ... 109
BRITISH PATENT SPECIFICATIONS. (Illus.) ... 115
BRITISH STANDARDS INSTITUTION ... 112
CATALOGUES ... 116
CURRENT PRICES FOR METALS AND FUELS ... 114
EDUCATIONAL INTELLIGENCE ... 116
FORTHCOMING ENGAGEMENTS ... 116
FRENCH ENGINEERING NOTES ... 115
MARKETS, NOTES AND NEWS ... 113
MISCELLANEA ... 101
PERSONAL AND BUSINESS ANNOUNCEMENTS ... 116
RAIL AND ROAD ... 101
SIXTY YEARS AGO ... 97

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CHANGES OF ADDRESS

**** Will Subscribers please note that in all advices regarding changes of address it is necessary to have* **both the old and new addresses,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

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THE HATED AEROPLANE

WHICH of us has not said at some time: "I wish the telephone had never been invented"? Which of us in his haste to turn it off has not thrown things at the "wireless," which of us has not at some time cursed the motor vehicle; which of us has not reviled tinned foods, or laid upon mass production the blame for shoddy production or the lack of artistic taste? So it must have been in every age since man began. No new thing comes in without some upsetting of the old; some dislocation and disturbance of accustomed ways. Years pass before we grow so habituated to them that they become part of our everyday lives. Like income tax and suburban trains, they cease to be "new-fangled." Generations spring up which never knew a world in which such things were not. Only in books and plays and pictures which date themselves do they look back upon times which are "the good old days" to each succeeding age as they pass into the distant, but the mediocre or bad new days to those who live in them. They sigh, romantically, for the easy-going, unhurrying, thorough-doing, life of their ancestors, forgetting that at no time, save perhaps in the Dark Ages, was there no invention, no progress, no hurrying and harrying of mankind, no novel and disturbing thoughts.

Each age is like its predecessor in this respect; no better and no worse, save that the rate of acceleration grows greater. The new invention reaches a position of maturity with ever-increasing velocity. The motor car and wireless came upon us almost overnight and the aeroplane sprung from an almost unimaginable thing into a reality in but a year or two. As long as it was a wonder, as long as Pegoud looping the loop or Bleriot flying the Channel were sports and spectacles exhibiting man's conquest of the invulnerable air, no one had a word to say against the aeroplane. When it gradually but rather quickly passed out of the wonder stage and flying became a "commercial proposition," still but few resented its coming. But when, as is the fate of nearly all things good and beneficent in themselves, it was turned to the evil purpose of dealing death broadcast, then the wish of Lord Baldwin that the aeroplane had never been invented was echoed in a thousand hearts. It cannot be denied that the art of flying is transforming the lives of men in a hundred unthought of ways. Man has conquered a new element and it is taking its revenge upon him. The sea has ceased to be a frontier and the cliffs a wall. Our Navy may keep the "narrow seas," but it cannot preserve this land from attack and conceivable invasion. In a handful of years the traditional security of this land against aggression has been obliterated; we are no longer as we were, a castle girt by a moat, but like our neighbours on the Continent vulnerable to another. Small wonder then that the air is to many an object of hatred and terror. Yet we must not allow our fears to overcome our sense of just proportion; we must not let the terrifying aspects of aerial navigation blind us to its valuable qualities. "Aviation," said Sir Kingsley Wood at the Society of Model Aeronautical Engineers a day or two ago, as reported in *The Times*, "aviation was meant to link the nations in bonds of friendship. It was by that means we should obtain what he might describe as the brotherhood of the air extending the world over—sharing the common ideal of good fellowship without regard to the divisions of nations or race. . . . When properly used it was one of the finest instruments for the promotion of friendly intercourse between mankind." All that is perhaps rather a high ideal; rather beyond the vision of lesser mortals at a moment when civilised cities are cutting catacombs, strengthening their "basements," and ringing themselves with guns and balloons in the momentary dread of enemy squadrons of the air. But high as it may be above the emotions of the day, it does keep us in mind of the fact that the aeroplane is in essence, and indeed in being, a new means of international traffic and intercourse of which we cannot yet see the full potentialities.

Possibly it may be well to recall that the very arguments which may be advanced against the aeroplane were in their day just as potent against railways and steamships, and in later years against motor vehicles. War turns to its uses the arts of peace. Nothing escapes. The tinned food of the picnicker becomes the iron rations of the soldier, the ships and trains and aeroplanes which carry us about our business or our pleasure are pressed into his service; the motor car and wireless, which are our playthings, are with him the instruments of his terrible craft. To wish that the aeroplane had never been invented, with Lord Baldwin; or, with others, to damn the high-speed internal combustion engine as the root of evil is in fact equivalent to condemning every improvement that man has ever made; for there is not one that may not be, that has not been, an accessory to or the actual means of destruction of man by man. It may be well to recall also that as each new means of destruction has been developed, new means of countering it have been invented. Protection against the warplane is taking that course. To quote once more from the Secretary of State for Air, "there are many limitations to the air weapon, and science and invention may well provide us with means of defeating the bomber, perhaps sooner than many of us realise to-day." Let us take heart of grace from that statement, forget the evil potentialities of the aeroplane, and remember that it, like the ship, and the train, and the car, performs services to mankind that outweigh its warlike functions.

Controlled Prices

To the student of industrial matters one of the most interesting features of modern business is the increasing prevalence of the system of controlled prices. In the simplest case the manufacturer decides at what price his goods shall be sold to the public and enforces his will by withholding supplies from any distributor who is detected in selling them for less. The argument for this policy is the protection of the retailers, on whose goodwill the manufacturer is largely dependent, from the competition of those who would be content with a smaller profit or even with no profit at all, if thereby they could increase their business generally. The next step is for the manufacturer to set about protecting himself, and this he does by coming to an undertsanding with his rivals whereby all undertake not to sell products of some particular kind at prices lower than are mutually agreed upon. Whatever be the form of organisation adopted for this purpose, whether it be a combine, a ring, a cartel, or merely a trade association, the primary effect is to standardise prices at a level satisfactory to the producers, and to mitigate, if not altogether to abolish competition between them. So thoroughly has the system of price control permeated commercial life that there is now hardly an industry of any importance in which there does not exist some powerful combination of firms, often international in its scope, which dictates what the buyer shall pay for its products. The primary consumers, whose purchases of material may be in tons or shiploads, are just as much subject to the system as the man who walks into a shop for an electric light bulb or an ounce of tobacco, and they in turn conform to the same principle by means of their own trade organisations.

All this, of course, appears quite contrary to the nineteenth century axiom that competition is the soul of trade. This aphorism was propounded at a time when industry was young, and when every manufacturer who could turn out a good article could keep his works full without undue striving after orders. The demand, or at any rate the potential demand, was greater than the supply, and competition was a thing to be encouraged in order to keep prices down and stimulate efforts for improvement in quality. Trade flourished under such conditions and the progress made was attributed to the effects of free and unrestricted competition. But such a state of affairs could not last. The multiplication of rival manufacturers, the perfection of their equipment for production on a large scale, and the necessity for keeping their expensive plants well occupied with work, resulted in many instances in prices being forced down to levels that threatened the ruin of them all. Competition overdone was becoming the curse of trade, for though it may have promoted the survival of the fittest, such firms as could survive became so debilitated financially that they were quite unable to spend money on the experimental and research work necessary to any technical progress. Some tried to maintain their existence by taking up foreign designs under licence, a course which only too often destroyed what enterprise they possessed and led eventually to an unhonoured end. Others struggled on, exhausting themselves in a ruthless price war with their competitors. The consumer really gained nothing in the long run, for technical developments were retarded, and even the apparent temporary benefit of low prices had to be considered in the light of the fact that one rarely gets more than he has paid for. In time the manufacturers in various industries combined in their own defence as the only means of putting a stop to a state of affairs which was ruining them, and thus there arose that network of trade agreements which plays so large a part in modern business. It is no good to argue whether trade combinations for the

control of prices, the apportionment of markets, and other voluntary limitations of individual enterprise are right or wrong, because they are the inevitable outcome of the evolution of industry. Their existence is not to be attributed to the inordinate greed of capitalists for profits, nor to any altruistic desire on the part of manufacturers to ease the strain on their weaker brethren. Their origin, as we have seen, is to be found in the instinct of self-preservation, called into action by the obvious results of unrestrained competition. That they are capable of abuse there is no room for doubt, but if all men were condemned for what they are capable of doing this would be a difficult world to live in. The consumer, however, confronted with dictated prices which he has no means of checking by quotations from other firms, is liable to feel that he is being exploited, and is angry because of his helplessness in the face of what looks like a conspiracy to take advantage of him. He maintains, quite reasonably, that it is absurd to suppose that every firm is being content with a legitimate profit when some must certainly be better equipped and more favourably situated than others for the supply of the particular article he needs. If, therefore, the price is satisfactory to the least efficient, or the most distant manufacturer, it must certainly be higher than the average maker would demand if he could quote freely, while it must afford an exorbitant profit to some of those tendering. It is no answer to say that the same consumer does not think he is unfairly treated because he has to pay as much for a letter to be delivered in the next parish as for its delivery in Australia, although the profits on the two transactions must differ greatly. He accepts the disparity because an organisation like the Post Office is a declared monopoly, there is no secret about its proceedings, and its business policy is nominally under the control of its customers. When a virtual monopoly is formed in private trade it is the element of secrecy which gives rise to suspicion. Only those inside the ring know how the prices are arrived at, so that it is only natural for outsiders to assume that they are simply fixed as high as it is considered that the market will bear. They must, at any rate, be high enough to provide a profit for the least efficient firms in the ring. Moreover, it is known that, in spite of the preachings of the apostles of mass production, many manufacturers hold that it is more profitable to produce a small output at luxurious prices than a large output at minimum prices. Such a policy certainly entails less trouble and risk, though it can hardly be considered as advantageous to the community in general.

Unless the firms in any trade organisation have some arrangement amongst themselves for pooling their profits, or for so adjusting their prices on large contracts that the consumer is virtually obliged to place his order with some predestined manufacturer, it is a great mistake to believe that all the benefits of competition have been eliminated merely by the fixing of uniform prices. What happens, in this case, is that competition takes another form. It is, for example, a common occurrence nowadays for the engineer of an electrical undertaking to receive quotations for transformers from a dozen or more different firms, whose prices are all identical down to the last halfpenny. In such circumstances he has to decide, not as was formerly the case, which firm will give him what he wants for the least money, but which will give him the best article for the price that he is compelled by the trade organisation to pay. The competition still exists, but it has been limited exclusively to technical matters, so that the best-designed apparatus will have the greatest chance of being selected. It may well be that a less efficient article at a competitive price would have been more acceptable had it been available, but if the engineer wants the best transformer he can get, the equality of the quotations has at least the advantage of relieving him from the invidious task of justifying his choice to some non-technical committee or accountant. It is this consideration which has no doubt caused the principle of uniform quotations to be accepted without much protest by purchasers of price-controlled apparatus, in spite of any uneasiness they may feel as to its ultimate effect.

Obituary

JOHN MACKWORTH WOOD

AMONGST the older men holding high positions in water engineering was Mr. J. M. Wood, whose death on July 21st at the age of eighty years we have to record. Mr. Wood began his engineering education at University College, London, and then, following the practice of his day, became first a pupil for two years with Ransome, Head and Jefferies, Ipswich; then for two years with J. and A. Blyth, marine engineers, London; and thirdly, for three years with Pontifex and Co., general engineers, London.

After this thorough training he secured a post as an assistant engineer on the staff of the New River Company, and in course of time was appointed assistant and resident engineer, the company's river engineer and surveyor, and, ultimately, the company's engineer. In this position he designed and carried out many large and important works, and gained exceptional experience in promoting schemes, preparing and giving evidence, and opposing Bills in Parliament.

Whilst he had a great knowledge of the water supply of London generally, his acquaintance with the River Lee watershed and valley as a source of supply was unequalled.

When the Metropolitan Water Board took over control of London water, he was appointed "New Works Engineer" for the whole undertaking, and was eventually made Engineer of the Northern District, practically half London, from which position he retired in 1924 after forty-five years' service.

Prior to the transfer of the New River Company to the Water Board, he had a considerable private consulting practice and advised a number of corporate bodies, water companies, and private individuals as to their water supplies, prepared schemes for them, and promoted their Bills in Parliament. On his retirement he considerably extended his consulting practice, and was at once retained by several County Councils, and river and canal authorities, and a number of water companies.

He was a member of the Institution of Civil Engineers, and a member of the Institution of Mechanical Engineers, and a fellow of the Society of Antiquaries, and of several kindred archæological and scientific societies, and wrote a number of important papers.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

THE NEW CONCEPTION OF BUSINESS

SIR,—From the leading article in your issue of July 14th it is evident that you think two things, namely, that the New Conception of Business is a nice idea, but that it will not work in practice, as those employed under it will desert it in times of adversity.

I do not think they will, and perhaps the following will convince you that I am right.

My theory or belief is that we human beings form theories or hold beliefs, and that these theories or beliefs determine our action. For example, you have a theory that the New Conception of Business will not work, and act accordingly, namely, do not actively support it.

My second theory is that we human beings endeavour to check the soundness of our theories by our actual experiences. My experience shows me that in the traditional business the human beings forming the group do desert each other in adversity, but it also shows me that in war time the human beings forming a group did not desert each other in adversity. Further, my observations tell me the same kind of human beings were involved in both examples.

I suggest therefore that neither the simple theory that human beings stick together nor the alternative theory that they desert each other in adversity is complete, one or more terms must be included. These terms may concern the nature of the adversity or the *raison d'être* of the group. The nature of the adversity in the two examples I suggest is the same, namely, shortage of food, clothing, and the other material blessings of life, but the primary objectives of the two groups are quite different.

In traditional business the primary objective is a material gain, whereas in war the objective was an abstraction, represented by such expressions as justice, honour, fair play, &c.

I suggest a more complete theory, therefore, is as follows:—Human beings forming a group will desert each other in adversity if the primary objective of the group is a material gain, but will more and more stick together as the primary objective is the attainment of the highest ideals of the individuals forming the group, *e.g.*, such ideals as justice, honour, truth, love, &c.

If this is a correct theory, since the primary objective of the New Conception of Business is to enable everyone to apply knowledge with integrity and express his individuality in the service of society, then I suggest individuals forming such groups—because they believe in the ideal—will hang together in adversity.

Our experience in the last few weeks confirms this. Last week, the cash position was such that after paying representatives' expenses and the salaries of the two going on holiday, there was no money left for salaries for anyone else. This position has been voluntarily accepted with a steady cheerfulness, as distinct from a heady enthusiasm.

Finally, should you—or, for that matter, any of your readers—like to see the New Conception of Business at work, I shall be pleased to show it.

FRANK MURPHY.

Welwyn Garden City, Herts,
July 19th.

RAILWAY RATES TRIBUNAL REVIEW

ON Saturday, July 15th, the Railway Rates Tribunal Review of Standard and Exceptional Railway Charges for 1939 was issued by the Stationery Office. The Tribunal finds that the railway traffic gross receipts of the four amalgamated companies, which in 1936 and 1937 were greater than in the preceding year by £5,900,000 and £7,200,000 respectively, continued to expand during the first ten weeks of 1938, after which a decline set in almost entirely in goods traffic, and by the end of the year amounted to a net decrease of £6,700,000. Passenger traffic also showed an improvement in the first eighteen weeks of the year, but it fell off in the later part of the year, and resulted in a net decrease of £300,000, making a net decrease in all traffics of £7,000,000, or 4·35 per cent., made up as follows:—L.N.E., £2,502,961; L.M.S., £3,063,904; G.W., £1,305,888; and S., £143,033. Railway working expenses in 1938 were greater than those of 1937 by £1,651,721, which amount is made up as follows:—L.N.E., £1,000,814; L.M.S., decrease, £241,902; G.W., £400,168; S., £492,641. The figures given show that the net revenues in 1938 were less in total than in 1937 by £8,918,003, which is made up as follows:—L.N.E., £3,454,275; L.M.S., £3,010,756; G.W., £1,842,752; S., £610,220. The average net revenue for the four companies for 1936–38 amounted to £34,205,751, leaving a deficiency of £17,153,334. The Tribunal finds that in the case of each of the amalgamated companies, the deficiency in the revenue is not due to lack of efficiency or economy in the management, and that the deficiency is likely to continue. Its decision against any change in the fares and the goods rates during the present financial year has already been announced. In the year ended December 31st, 1938, each of the four companies expended substantial amounts on capital account, the total for the four companies being £8,828,631; but as no additional capital raised or provided in respect of such expenditure, no claims for allowances were made.

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Evolution of Physics. By A. Einstein and L. Infeld. London: Scientific Book Club, 111, Charing Cross Road, W.C.2. Price 2s. 6d. net.

An Introduction to Modern Geometry. By L. S. Shively, Ph.D. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 10s. net.

Fundamental Theory of Arc Converters. By H. Rissik, B.Sc. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 18s. net.

Building Design and Construction, Volume I. By Dipl. Ing. F. J. Samuely and C. W. Hamann. London: Chapman and Hall, Ltd., 11, Henrietta Street, W.C.2. Price 25s. net.

Boiler Feed Water Treatment. Second edition. By F. J. Matthews, B.Sc. London: Hutchinson's Scientific and Technical Publications, Paternoster House, E.C.4. Price 12s. 6d. net.

Studies in Reinforced Concrete: V, Moment Redistribution in Reinforced Concrete. By W. H. Glanville, D.Sc., and F. G. Thomas, Ph.D. London: His Majesty's Stationery Office, York House, Kingsway, W.C.2. Price 1s. 3d. net.

An Electrical Stampings Works

FROM an old-established merchanting and agency business in the steel and electrical trades, George L. Scott and Co., Ltd., began to manufacture dynamo, motor, transformer, and meter stampings in 1931 at Acre Lane, Brixton. A year later the works were transferred to Kingsway, Croydon, while the offices and stores remained at Brixton; but needless to say, this division of establishments was unsatisfactory, and in due course temporary premises for clerical work and the storage of material and finished products were acquired at Croydon. The first extension of the offices and stores in the form of the single-storey building shown in Fig. 1 was built in 1934, whilst in 1937 the works were more than doubled in size and a building with a gallery shown in the background of the picture was built.

The flow of material through the works is arranged to avoid as far as possible manual handling. Sheets received at the east end are conveyed on an overhead crane and runway to the steel store, where they are stacked according to grade and thickness. From the store the sheets are fed by a runway to the power guillotines, where they are cut into strips, &c. In Fig. 2 are to be seen the platforms on which the strips are transported, and in the distance the control office where the strips pass the weighbridge and are checked for weight against a works card which remains with the material until it is used up. When several operations are necessary to complete the process, the material is checked at the progress office after each operation to ensure that no wastage has occurred. If wastage is noted the cause is investigated and rectified before the next operation is begun. On the right of Fig. 2 part of the small transformer section of the presses is shown.

The works manager, Mr. T. H. Robins, A.M.I. Mech. E., has specialised in the design of the combination tools for high rates of production with great accuracy. Tools for the production of transformer laminations in particular are designed with a view to the greatest possible economy in material and labour, and in most cases the laminations are automatically stacked at the presses. Field and armature stampings for vacuum cleaners, hair dryer motors, and other fractional horsepower machines, are produced on combination tools designed to ensure accurate registration of slots and rivet holes. Normally, stators and rotors for A.C. machines and the armatures for D.C. motors are notched on a battery of new automatic notching presses at rates varying from 400 to 600 notches per minute. These presses have balanced fly-wheels and an enclosed driving mechanism with very fine adjustment for setting. Although considerably higher speeds of notching are obtainable, in the long run the speeds mentioned are considered to be the most economical consistent with accurate work. But although the production is very satisfactory, it is not so good as that obtainable with complete combination tools which produce the notches with one blow. The company has specialised in the production of this type of tool and has developed it to a high state of perfection. Whilst slight inaccuracies may occur in slotted stampings produced on notching machines, particularly at the beginning and finishing points, absolute accuracy is said to be obtained with the one-blow method and the slot spacing is true within very fine limits.

The advantage of each stamping being an exact replica of its neighbour is that a perfectly clean core results, and winding is facilitated. Moreover, supplies of stampings from various consignments can be used together. The method is said to be economic and to justify the tool outlay for comparatively small quantities up to a diameter of 16in., although at the moment the firm is concentrating on somewhat smaller sizes.

The presses to be seen in Fig. 2 are used for the production of laminations generally used in the wireless trade and known as Ts, Us, Es, and Is for small transformers. The tools are of three kinds, known in the trade as full combination, follow-on stage, and follow-on closed stripper tools. The first has spring-loaded releases and the punches and dies are parallel, the blanks returning back to the strip. The standard of production from this type of tool is very consistent, the stampings being identical and the best type of the kind. The other tools are used for competitive reasons. Generally speaking, the stampings have slight variations with respect to one another owing to the operations being split up. While it is impossible to trough the stampings on the combination tool, the follow-on tools are destined for the stampings to pass through them into troughs at the bottom of the machines.

A section of the works devoted to the production of A.C. and D.C. motor stampings is shown in Fig. 3, and illustrates machines used for the early operations, or, alternatively, for producing stampings in one blow. There are several methods of producing such stampings. Referring to Figs. 6 and 7, the process of making these stampings with plain tools would entail plain blanking the outside of the stator, then blanking the centre out of that disc, thus making a washer. Next, the smaller disc obtained out of the washer would have a centre hole and keyway punched in it, thus producing a stamping ready for the slots. The stator ring also has to be provided with rivet holes in addition to slots. Hence it will be seen that this is a slow and costly method of manufacture, but it is employed in the trade for producing samples for new designs.

When a design has been standardised and large

FIG. 1—EXTERIOR VIEW OF WORKS

FIG. 2—SHEET SHEARING SHOP

FIG. 3—A.C. AND D.C. MOTOR STAMPINGS SHOP

quantities of stampings are required without alteration, combination tools combining the operations described are as a rule justified. Several methods of production in accordance with this plan are employed, but the best-known makes use of a tool with spring releases as previously mentioned and parallel steelings. Incorporated in these tools are punches for producing the rivet holes, the centre hole, and keyway; in fact, everything except the notches which are stamped out on high-speed notching machines. This is a fairly competitive method of producing stampings of good quality. But an improvement on the method is to use a strip of material wide enough to give the outside diameter of the stator and to pass it through a follow-on tool, which punches a centre hole and slots in the rotors and spaces them so that the strip of material can be passed through another tool for producing a complete rotor and preparing the stator rings for slotting. Many variations of this method have been tried, and it is pretty obvious that all sorts of operation combinations are possible.

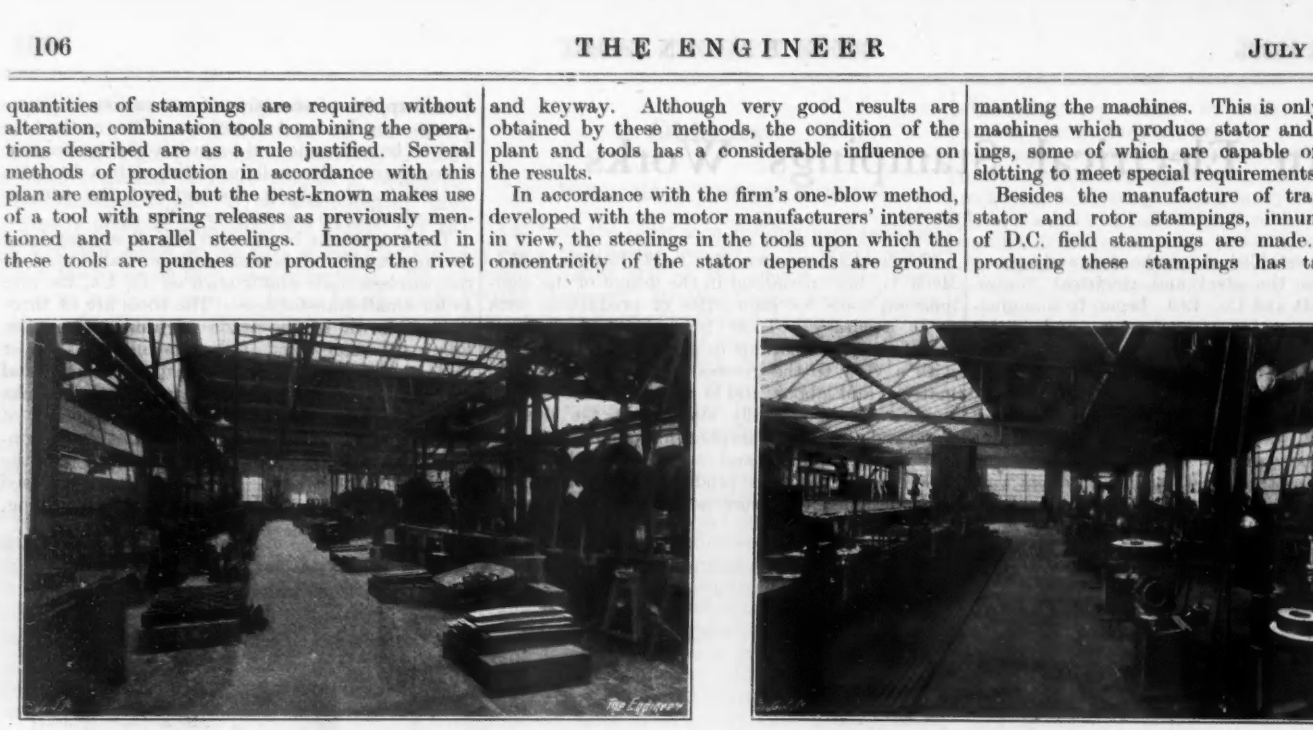


FIG. 4—NOTCHING PRESS SHOP

FIG. 5—TOOL SHOP

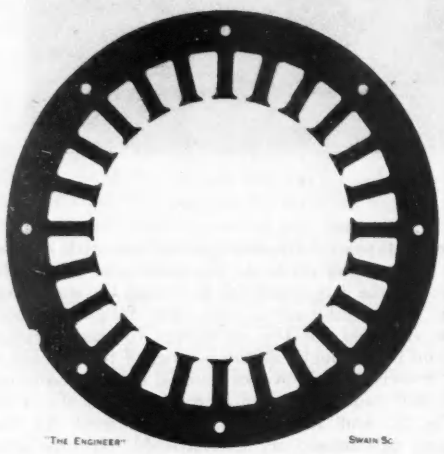


FIG. 6—STATOR STAMPING

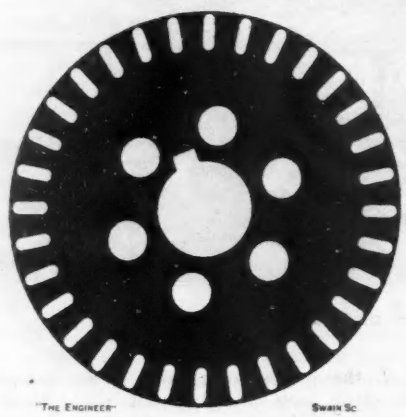


FIG. 7—ROTOR STAMPING

The ideal to be aimed at to satisfy stamping users is the production of perfectly concentric stator ring containing notches and rivet holes in alignment so that blocks of stampings can be built up without discrepancies. The rotor slots should be in a similar relation to the centre hole and keyway. Although very good results are obtained by these methods, the condition of the plant and tools has a considerable influence on the results.

In accordance with the firm's one-blow method, developed with the motor manufacturers' interests in view, the steelings in the tools upon which the concentricity of the stator depends are ground at one setting, the rivet holes, slots, bolt holes, centre hole, and keyways are produced in one operation. The tools are made by a special process which gives a fine limit to the size and spacing of rivet holes and slots. When the stator stampings are built up, the alignment of the slots and the fitting of the rivets are perfect. Similarly, when the rotor stampings are mounted upon a shaft and key, perfect alignment of the slots is secured and when the core is ground down to produce the air gaps the concentricity of the slots with respect to the centre hole gives a perfectly balanced core.

On the left of Fig. 4 is shown a row of notching machines designed by the works manager for special use. Advantages of these machines are quick setting, high speed of operation, and good quality work. An idea of the utility of the machines can be gauged from the fact that the smallest machine for rotors will produce from six to approximately 130 slots, whilst the size of the stamping can vary from $\frac{3}{4}$in. diameter to 13in. diameter. The toolholders enable the tools to be instantly changed, and the bottom toolholder has a fine vertical adjustment for alignment with the stampings. Adjustment of the throw to suit any number of slots is obtained by a rack working in a toothed wheel which governs the spindle on which the stamping rotates with the help of a friction band. The operation of changing the register plates and dividing wheels is done from the top of the spindle without dismantling the machines. This is only one of eight machines which produce stator and rotor stampings, some of which are capable of intermittent slotting to meet special requirements.

Besides the manufacture of transformer and stator and rotor stampings, innumerable types of D.C. field stampings are made. The art of producing these stampings has taken a good many years to perfect. It has been found that the disadvantages of four or five stage tools is the spacing of the stages which has to be varied to produce the stampings correctly. Metal passing from stage to stage stretches and distorts, and when it is realised that each piece of metal is slightly harder or softer than another, or even varies in different places in a strip, trouble in operating such tools is not surprising. With the exception of very skilled tool-making there is little difficulty in providing the correct type of tool. Experience has shown that the practice of reducing the number of stages and of aiming at getting as near as possible to a combination tool is the best method of producing these stampings; but consideration must be given to the possibility of stamping field and armature laminations from the same plate to eliminate waste.

In the tool room (Fig. 5) all the tools and various attachments used on the firm's special presses are made, and, as in other parts of the factory, care is taken to ensure an even flow of work without overlapping, the machines ensuring that the fitters are fed with work at the correct rate. The furnace equipment enables blanking tools up to 24in. in diameter to be hardened.

An apprentice scheme in operation covers complete press tool-making and a period in the drawing office. Technical instruction is given by the Croydon Polytechnic. Usually apprentices are allowed one day per week to take classes and the fees are paid by the firm.

The Disturbing Forces in a Locomotive*

No. II

(*Continued from page 82, July 21st*)

Elastic Deformation of Track.—This important initial condition to permanent deformation and derailment, namely, the extent of elastic spreading of gauge, can easily be verified by applying a jack between the heads of the two rails; it will be found that a considerable force will have to be applied, causing an appreciable spreading of the gauge, before any permanent distortion is left, after the jack is removed. It is possible, therefore, for an engine to bring about equally large track deformations and to leave no trace afterwards, although the deformations have been sufficient to promote severe lateral reactions. Elastic spreading of the gauge may be caused by one or more of the following:—

(*a*) Vertical play under spike or screw heads.

(*b*) Lateral play due to looseness of fastenings.

(*c*) Rotation of the bull or double-headed rail about its support.

(*d*) Flexing of the F.F. rail about its base, if lateral stiffness is insufficient.

(*e*) Bending of the sleeper, if it is of the rigid type; spreading and/or tilting of the pots or plates, if the sleeper is of the semi-rigid type with a tie bar.

(*f*) Insufficient number of sleepers to compensate for relative lightness of rail, and/or weakness of formation.

(*g*) Absence or looseness of keys on bull or double-headed rails, and of wedges on steel trough sleepers with F.F. rails.

In this connection we would emphasise that the term track defect is relative. Most of the defects outlined above can start even a well-designed engine hunting if they are sufficiently pronounced; but even within normally accepted standards of track maintenance they are sufficient to start an engine hunting, if it is badly designed as a vehicle and in a bad condition of maintenance. Speed also is of the essence of the problem. The higher the speed, the smaller is the range of permissible imperfection in either track or engine; on the other hand, the effect of undue oscillation can always be brought within the range of safety by a sufficient reduction in speed.

The fact that track and engine parts deflect elastically suggests the possibility of resonance between the nosing oscillations of the engine and the natural period of the track, or engine frame, considered as a form of spring; such resonance has been suggested as a contributing factor in the building up of oscillation. The ascertained period of nosing of an "X" class "Pacific," taken from numerous high-

* Chapter III of the Report of a committee appointed to inquire into the purchase and use of "Pacific" locomotives in India.

speed tests, lies between 0·75 and 1 second. Although no tests have been made of the natural period of track, considered as a spring, it is obvious, in view of its lateral stiffness, that its period must be something very much less than 0·75 second. A resonance effect, therefore, seems to be unlikely.

In practice, the relationship between engine and track is not so simple as outlined above, and, in fact, it is highly complex; experimental verification is therefore of the first importance, and this aspect of the matter will be dealt with in Chapter VII. Lateral deformation of the track under load represents only one of the elements giving rise to high flange forces. The moment of inertia of the locomotive about a vertical axis through its centre of gravity represents another. Without guiding wheels, a light short engine would be expected to produce only small flange forces, but a heavy engine with a large overhang fore and aft would produce large flange forces.

Effect of Engine Rolling.—It has been stated that when a wheel flange strikes the rail, unloading of the opposite wheel due to rolling of the sprung mass of the locomotive is also an element which influences the building up of transverse oscillation on the track. The characteristics of the bearing springs are important. The more flexible the springs, the less the amount of unloading of the wheels; very stiff springs may even cause derailment before material deformation of the track takes place.

Also, just as the longitudinal moment of inertia of the engine has its influence on the flange force, when one of the leading coupled wheels strikes the rail, so the transverse moment of inertia, the height of the centre of gravity, and spring stiffness have effect on the amount of weight which is transferred from one wheel to another on the same axle, as the engine rolls. For springs of given stiffness this value will be affected by variation in the cross section of the engine, and particularly as weight is disposed at a distance on either side of the centre line. Side tank engines are thus more prone to rolling than tender engines.

The engine rolls on a base which is represented by the distance between the transverse centre lines of the axle-boxes. The greater this distance, the less will be the periodic time of rolling, and a broad-gauge engine should, other things being equal, be somewhat less prone to rolling than a narrow-gauge engine.

These features, concerned in rolling, are important, but they have this in common, that they are much less amenable to control for the sake of good riding than are such matters as side clearances and length of wheel base. Flexibility of the springs, for instance, is severely limited in all cases by other considerations of design. The extreme range of spring deflection, which is attainable in ordinary designs, is from 0·15in. to 0·35in. per ton, in the case of coupled wheels. Further, when power requirements have been met, the cross section of the engine is capable of but little adjustment, while the distance between axle-box centre lines is governed by the gauge of the permanent way.

Practical tests show that there is little possibility of purely rolling oscillations building up because of the damping effect of the laminated bearing springs. Therefore, whilst the significance of the foregoing factors must be borne in mind, we must turn to other considerations in engine design for factors which can be of use in the control of hunting. In so far as rolling is a contributory factor, vertical deflection of the track is one of the decisive elements, and, in this connection, stiffness of rail joints and packing of sleepers assume importance. These matters will be dealt with in Chapter IV. Staggered joints may also have some influence, *vide* paragraph 52, Chapter II.

Running of "Pacific" Type Locomotives on the Track.—What we have said for a locomotive without guiding wheels is equally true for an engine having such wheels, if, for certain reasons, these do not effectively perform their functions. If the main frame of a "Pacific" locomotive is free to move transversely in relation to the bogie and hind truck, and if the cross slides offer no resistance (as, for example, if they were fitted with roller bearings), the guiding of the engine on the track would be performed solely by the coupled wheels, the wheel base of which is generally short on a 4–6–2. The overhang, front and rear, will be considerable from the point of view of nosing, and in these circumstances the engine can assume an excessive angularity with the track. There would therefore be undesirably large flange forces at the leading coupled wheels, even at relatively low speeds. A "Pacific" under these conditions would run less satisfactorily even than an 0–6–0 type, because the latter is not, in practice, provided with so large an overhang.

The above represents an extreme case, but it shows how necessary it is to provide certain characteristics to decrease, so far as possible, flange forces at the leading coupled wheels. The ideal value to be aimed at for these forces is zero, when the engine is running on straight track. On curves this cannot be attained, but the lowest possible value must be sought. To achieve the best results, and to relieve the leading coupled wheels as much as possible of any guiding function, it is not sufficient only to provide a bogie; the bogie must have the greatest permissible centring force in relation to the weight it carries. Engineers have sometimes been reluctant to take this course, feeling that any flange force taken off the coupled wheels in this manner was simply added to the bogie wheels, thus transferring the possibility of derailment to those wheels. Such, however, is not the case, and it can be shown that it is possible to decrease, to a considerable degree, the reactions on the leading coupled wheels by increasing to a small extent the flange pressure on each of the two bogie wheels.

For example, in the case of an "X B" engine, the distance from the leading coupled wheel to centre of gravity is 5·83ft., and from bogie centre to centre of gravity is 14·58ft. Assuming that the guiding reactions have the effect of deflecting the engine round a vertical axis passing through its centre of gravity, the transverse force to be applied to the engine to obtain a given rotation is inversely proportional to the distance of the point of application from the axis of rotation. By increasing the lateral reaction on each bogie wheel by 1 ton, it is possible to relieve the leading coupled wheel flange pressure by about 5 tons. An actual increase therefore in the centring force of 4 tons applied to the bogie, as a whole, would decrease the flange pressure on the leading coupled wheels by about 10 tons. This states the problem in the simplest terms, but in practice the values are affected by friction and other considerations.

From trials made in France and for the special features of French track, Blondel[9] has found, by means of special tests with rolling loads on main lines in the worst condition, that it is possible to apply a side pressure equal to 40 per cent. of the vertical load without risk of track displacement. This proportion must, of course, be verified for representative conditions in each country, having regard to the varying natural features and standards of construction. In India it should be possible to adopt 40 per cent., because the conditions of track appear to be no worse than those under which Blondel, by means of deliberate preparation, obtained his limiting figure. Reverting to the simple illustration referred to above, it follows that, with a vertical load of 20 tons on the bogie wheels, it is possible to have a centring force of 5 to 6 tons, which should be able to decrease the coupled wheel flange forces by 12 to 15 tons; in effect, this would practically suppress them on the straight. It is evident that lateral pressure of 2½ to 3 tons on each bogie wheel will not have the same effect on the track as a pressure of 12 to 15 tons on the leading coupled wheels.

The best that can be done on the engine has been clearly shown to be the reduction of coupled wheel flange forces. This can be achieved by increasing, so far as is practicable, the side control on the bogie, having regard to the characteristics of the hind truck. This, in essence, is the most important practical measure which can be taken in engine design to reduce the reactions on the track.

The Effect of Engine Wear and Maintenance.—The above considerations have been largely theoretical, but in practice there are a number of factors entering into the problem which tend to detract from the parts played by the bogie and hind truck in the guiding of the engine. There is, for instance, side play of all kinds, which delays the instant when the centring action of the bogie and hind truck begins to take effect, after a side displacement of the engine. The different factors can be described as follows:—

(1) Side play of bogie pivot pin in the bogie centre casting.
(2) Flexing of the engine main frame, between the bogie pivot and the leading coupled axle.
(3) Side play of the axle-boxes in the horns of bogie and hind truck.
(4) Side play of the bearings on the journals of bogie and hind truck.
(5) Clearance between flange and rail in the case of bogie and hind truck.
(6) Working of bogie control springs in opposition, at the beginning of their stroke, owing to bad fitting or wrong design.
(7) Breakage or loss of strength of control springs.
(8) Flexing of bogie frames.

If the total of all these displacements and deflections is considerable, the guiding of the engine, whatever the amount of the spring control, will be practically provided by the coupled wheels, for all angular displacements of the main frame, which do not entirely absorb the side clearances. This is the very condition which should be avoided, if possible, and it is at this point therefore that the maintenance of the engine assumes importance. This is dealt with in Chapter VI.

If, in addition, the initial spring control is too weak, an additional displacement will occur, which will be greater as the displacement-load curve of the control springs is flatter. This factor will have to be added to all the others before effective control of the engine by the bogie begins. It will therefore be realised that, while bogie side clearances have an important bearing on all engines, their effect is increased on engines with weak spring control.

The Effect of Weather.—Although at first sight remote from the problem of hunting, the weather, as affecting the state of rail surface, can become a factor of some importance. It has already been shown how the limits of adhesion affect the way in which an engine, striking one rail obliquely, will be deflected towards the other, depending on the circumstances in which lateral slipping of the wheels on the rail can occur. Obviously, with a dry rail slipping will occur much less readily than with a wet or greasy one.

Trials have been made in France in which, in a certain type of electric locomotive, hunting was proved to be due to a defect in design, which made itself felt when lack of rigidity and insufficient packing of the track were present. In other words, it was a borderline case. Even after these factors had been traced and evaluated, the inconsistency in the behaviour of the engine was not accounted for, in that it would hunt over a given piece of track on one occasion and not on another. At the time no explanation could be found for this, and it was only later when testing a different type of locomotive that the state of the rail was found to be a determining factor.

Under greasy rail conditions lateral slipping is produced for relatively low flange forces, and the effect of the elements which make for building up of oscillation is reduced. On the other hand, under monsoon conditions, when in other respects track condition is at its worst, adhesion may be extraordinarily good should the rail be dry. When the rail has been well washed by heavy rain and then dried by the heat a light coating of oxide can rapidly form (particularly under conditions of low traffic density), which will increase the adhesion and consequently increase the tendency to hunt. The weather is obviously a condition which cannot be altered, but its effect on the variability of results is worthy of note.

The Effect of Friction.—The total initial side controlling force on bogie or hind truck is the sum of two forces, namely, that due to the springs, links, or inclined planes, and that due to friction. These forces may combine in any proportion, according to the design and state of maintenance. A swing link bogie, for example, will have a minimum of friction, as there are no sliding surfaces, while a bogie with a cross slide, faced with friction material, can have greater frictional controlling force than spring force, if a weak spring be fitted. In the case of laminated springs there is also friction between the plates. Moreover, the amount of friction present will vary with the state of lubrication of the sliding surfaces.

So far as initial control is concerned, it is of little consequence whether force is provided by spring or friction or any combination of the two. As soon as any side displacement takes place, however, such frictional force as exists will add itself to the spring control for outwards movement, but it will be subtracted from the spring load on the return, and in extreme cases, if friction is high and the spring weak, external work will actually have to be done on the bogie to restore it to its central position. This is very undesirable on curves, since high leading coupled flange forces may result from the virtual cancellation of the controlling force in the return direction. While some degree of friction is inevitable, it is necessary, therefore, to keep it to a relatively low value. High friction and low spring control will give high coupled wheel flange pressures on curves; high spring control and low friction, while giving the same controlling effect on the straight, will also assist in taking some of the load off the leading coupled flanges on curves. It is important, in any given design, that the coefficient of friction between the sliding parts should be known and should remain between close limits. The above comments would not apply should damping devices be used which are free from friction.

Magnitude of the Controlling Force on the Bogie and Hind Truck.—It has been pointed out that a limited controlling force, acting through an arm which is longer than that of the coupled wheel base, can efficiently control both ends of the engine and replace high flange pressure between the coupled wheel and the rail by well-defined forces applied at the bogie and hind truck flanges. The value of these forces for a new design should be determined experimentally in order to avoid excessive pressure between the coupled wheel flanges and the rail. Alternatively, these forces can be calculated from those existing on some former engine, which is known to exert low pressures; the values so obtained should be checked by experiment after the new engine has been running. This will give the most suitable initial value of the control.

When running at high speed on a curve side displacement of both bogie and hind truck occurs and the engine is in equilibrium under the action of three moments. One is given by the action of the bogie control; another, of opposite direction, is given by the hind truck control; and the third, in the same sense as the latter, arises from the natural tendency of the engine to follow a tangential course, due to centrifugal force. When the bogie side control balances the sum of the hind truck and centrifugal reactions the movement of the engine round a curve will be similar to that of an engine without a bogie on the straight; it results in heavy flange forces at the leading coupled wheels. Again, if the spring control of the bogie is of greater value, but is not strong enough to avoid such high forces, the whole mass of the engine will be turned in a pivotal and jerky manner towards the inside of the curve, when track irregularities are present.

From the foregoing we have shown how to determine the initial control. It is now necessary to ensure that the bogie control, at maximum displacement, does not exceed a certain percentage of the vertical load on the track. On very good track this figure may, according to the French experiments already mentioned, attain 70 per cent. of the vertical load, but it

[9] *Revue Générale des Chemins de Fer*, December, 1932.

is not advisable to exceed 40 per cent. Owing to the necessity for limiting the final control it is important to keep the maximum side play of the bogie as small as possible, consistent with free passage round the sharpest curve.

It is necessary to conduct final tests, using flange force recorders, to verify the chosen values; in carrying these out care should be taken not to vary more than one factor at a time. For example, each set of variations of the bogie spring control must be made with the same setting of hind truck control. It should be noted that any variation in the strength of the hind truck control has the same effect on the behaviour of the engine, as an opposite variation applied to the bogie control, so far as curves are concerned. Methods of carrying out tests and recommendations in this respect are contained in Chapter VII.

Determination of the Amount of Lateral Spring Control on the Bogie, Based on that of Engines which are Considered to Run Satisfactorily.—As already explained, in order to limit nosing movement, it is necessary to introduce some degree of lateral control at the front end of the engine, as far as possible from the centre of gravity. This control sets up a force which opposes the nosing movement when the frame is deflected from its central position. The value of the resulting moment must have a certain relation to the moment of inertia of the engine.

Assuming, for example, that the initial control on the standard B.E.S.A. 4–6–0 type engine is satisfactory at high speeds on existing track, it should be possible to determine the value of the side control on the "X B" class, to ensure equally satisfactory flange forces.

For the 4–6–0 type engine, let:

I = the moment of inertia about a vertical axis passing through the centre of gravity (tons-feet).
d = distance between centre of gravity and centre of bogie pin (feet).
F = initial compression in the bogie side control springs (tons).
P = vertical load on bogie (tons).
f = coefficient of friction of the bogie slides.

Also, let I^1, d^1, F^1, P^1, and f be the corresponding values for the "X B" class. The centring force, resisting initial displacement, is made up of spring and friction forces, the value in the case of the 4–6–0 type being $(F+Pf)$, and (F^1+P^1f) in the case of the 4–6–2 type. We can now set down an equation for the moment of the centring force about the centre of gravity of the engine; this is proportional to the longitudinal moment of inertia of the engine about a vertical axis.

The equation takes the form:

$$\frac{(F+Pf)\,d}{I}=\frac{(F^1+P^1f)\,d^1}{I^1}.$$

Whence

$$(F^1+P^1f)=\frac{(F+Pf)\,I^1\,d}{d^1}.$$

Assuming that

$F=0\cdot75$ tons.
$P=18\cdot5$ tons, and $P^1=18\cdot0$ tons.
$f=0\cdot1$ (for lubricated slides).
$I=3477$ tons-feet, and $d=12$ft. $7\frac{1}{4}$in.
$I^1=6542$ tons-feet, and $d^1=14$ft. 7in.

Therefore the total resistance to displacements at the bogie of the 4–6–2 type

$$=(F^1+1\cdot8)\text{ tons}=\left\{(0\cdot75+1\cdot85)\,\frac{6542}{3477}\quad\frac{12\cdot65}{14\cdot6}\right\}\text{tons}$$
$$=4\cdot25\text{ tons.}$$

Thus the value of the total force resisting initial displacement is 2·6 tons, in the case of the 4–6–0 engine, made up of 0·75 tons spring and 1·85 tons friction, while the corresponding value for the "X B" engine is 4·25 tons, made up of 2·45 tons spring and 1·8 tons friction. This calculation assumes that the "X B," like the 4–6–0 engine, has no controlling force acting at the rear. A "Pacific," however, has a trailing truck, which also offers resistance to lateral movement, either in the form of a control spring (or inclined planes) plus the friction of the sliding surfaces, or, in the form of friction only, as in the case of a trailing radial axle-box with flat sides.

If a "Pacific" engine is oscillating on straight track, compression of, say, a left-hand bogie control spring will concide with compression of a right-hand truck spring, as the centre line of the engine forms an angle with the centre line of the track. The resistance offered by both springs, as well as that due to friction in all the slides, will add together and tend to keep the engine straight on the track.

On the other hand, on entering a right-hand curve, the left-hand bogie spring will be compressed as before, but in this case it is the left-hand truck spring which will be compressed, and the latter is tending to turn the engine in the opposite direction to the former. The side control on the truck is thus in opposition to that on the bogie, and, in such circumstances, in order to allow the bogie on a 4–6–2 engine to have the same effective controlling action as on a 4–6–0, it is necessary to increase the value of the moment due to the bogie control by the corresponding opposing moment due to the truck. For instance, we may assume that there is an initial control on the trailing truck of 2·5 tons, which may be made up of spring plus friction, or all friction, according to design of truck; also that the arm at which this force acts is 15ft. 4in from the engine C. of G.

Correcting this in proportion to the length of arm from C. of G. to bogie centre, we obtain a value of

$$\frac{2\cdot5\times15\cdot33}{14\cdot58}=2\cdot63\text{ tons.}$$

The total initial control of the bogie should therefore be $4\cdot25+2\cdot63=6\cdot88$ tons. But of this force 1·8 tons arise from the friction of the bogie slides under a vertical load of 18 tons. The value of the initial spring control given to the "Pacific" engine should therefore be $6\cdot88-1\cdot8=5\cdot08$ tons, in order to provide a sufficient degree of control on curved as well as on straight track.

As already indicated, the bogie control at final displacement should not exceed 40 per cent. of the vertical load on the rails. For the "X B" class this is 40 per cent. of 22·6 tons = 9 tons total, or a final spring tension of $9-1\cdot8=7\cdot2$ tons. Therefore, for this class of engine, the bogie control should be, say:

Initial 5 tons ... Final 7 tons

Similarly, assuming a coefficient of friction of 0·1, the figures worked out in the same manner for "X A" and "X C" engines are:—

"X A" ... Initial 3½ tons ... Final 5 tons
"X C" ... Initial 5½ tons ... Final 7 tons

The above shows how the amount of side control may be determined in principle, based on known values for a 4–6–0 engine; but detailed adjustments should be made in these values, or, alternatively, in the amount of hind truck side control, when the spacing of the truck from the adjacent coupled axle is varied from standard.

The preceding discussion shows clearly that by increasing the arm of the moment of the centring force at the rear (for example, by increasing the distance between the hind truck and the trailing wheel or by increasing the inclination of the Cartazzi slides), the initial controlling effect of the bogie on curves will be weakened.

It must not be forgotten that damping of the nosing movement, by friction on the slides, can in certain circumstances, especially on the straight, improve the riding as observed on the footplate. This represents, however, only that part of the oscillation of an engine which relates to movement, and does not necessarily give any indication of the magnitude of the forces which arise from the reactions between wheels and rails.

Other Influences on the Locomotive as a Carriage

In addition to the foregoing, certain other features of design have to be considered. These are:—

(*a*) Position of bearing springs.
(*b*) Length of bearing spring links.
(*c*) Nature of connection between engine and tender.

(*a*) *Influence of Spring Position Above or Below Axle-boxes.*—When springs are below the axle-boxes, when links are in tension, and when lateral displacement of the frame in relation to the axle occurs, the spring and its links are inclined in the same direction; the full length of the link is then effective in exerting a centring force to return the frame to its normal position. In such a case, the spring is mounted in stable equilibrium.

When, on the contrary, the springs are above the axle-boxes, they are mounted in unstable equilibrium, because, when the frame is deflected from its normal position, the spring has a natural tendency to capsize, even if it is guided. This capsizing tendency has the effect of reducing the inclination of the link, which, in turn, reduces the centring force. It should be noted that if the lateral play between axle-box and guides is small, there is theoretically little difference between the two methods of suspension.

The effect of mounting the springs above the axle-boxes is made worse in proportion as the spring camber and the length of the links are made greater. In these circumstances, there is a tendency for the axle-box guides to lean over against the axle-box, with a definite pressure on one side or the other. This may give rise to undue lateral wear in the guides and boxes, the clearances increasing in a cumulative manner. Moreover, the heavy unrelieved side pressure on the guides, which sets up friction in a vertical direction, can prevent the free rolling movement of the spring-borne mass of the engine, and may give rise to further unloading of wheels.

Generally speaking, and for the reasons mentioned above, we recommend that unstable arrangements be avoided for springs, links, and compensating gear, in the case of new designs. On the other hand, it must be recognised that there are many thousands of engines in the world with overhead spring gear, and there are often sound practical reasons which will justify its use. When well designed, the actual practical drawbacks are hardly noticeable, and in view of this there can rarely be any justification for reconstructing an existing engine to obtain an underhung spring position.

(*b*) *Influence of Length of Spring Suspension Links on the Side Movements of the Engine.*—A locomotive is suspended at the ends of its spring links in the same manner as a pendulum. For a given transverse displacement the centring force is inversely proportional to the length of the links, while the period of oscillation is proportional to the square root of the same length. Therefore, for a given side play in the axle-boxes, a main frame suspended by long links will remain out of centre for a longer time than it would if short links were used. For the same reason the side pressure of the guides against the axle-boxes will be greater with long links, because of the lower value of the centring force.

If a blow occurs between rail and wheel when the edges of the guides are in contact with the axle-boxes (as frequently happens with long links) the blow will not be reduced by any vertical component due to the inclination of the links, and the frame will move from side to side with alternate blows, the intensity of which increases in proportion to the side play.

On the contrary, with short links, the movement will be rapidly damped out, and the frame will be more readily maintained in the central position in the guides. It is clear that if there is any side play between boxes and guides on a new engine (and some such play is essential), increase in the side play by wear will tend to be greater with long links than with short. As in the case of springs, the relative effect of long links is limited within the working side clearances, whereas a short spring link is recommended for new construction, the suppression of long links, where they exist, can hardly be justified by practical considerations.

(*c*) *Nature of Connection Between Engine and Tender.*—If an engine is able to run with satisfactory stability on both straight and curved track, exerting minimum flange forces, it is self-sufficient as a vehicle, and there is no need for anything but an articulated link to connect it to its tender. On the other hand, as few engines attain perfect stability, it will be noted that some attempt in most designs has been made to tie up the engine with its tender, so that the inertia of one may be used to damp out the oscillations of the other, depending on their relative natural stability. This is usually obtained by some form of spring side buffer, and on the straight this form of connection has the effect of lengthening the virtual wheel base.

On curves the effect of intermediate buffers differs according to the particular arrangement. If the buffers are equalised, so that they both continue to exert the same force on the buffer beam on both sides of the horizontal centre line, the only force transmitted to the chassis of the engine is that due to frictional resistance, depending on the strength of the buffing spring and on the coefficient of friction between buffer head and beam. In some designs the buffer heads work on inclined planes. The buffers always try to centre themselves in the V formed by the inclined planes, and, in consequence, tend to equalise the throw-over of the back end of the engine and the front of the tender. As the throw-over of the former is usually greater than the latter, there is, in consequence, a centring force which tends to move the rear of the chassis of the engine towards the inside rail, *i.e.*, in the same direction as the trailing truck side control is acting and in opposition to the bogie control on a curve.

Where the tender is of six-wheel type or of bogie type without any provision for side displacement, and where the engine is of the "Pacific" type, with long overhang behind the trailing coupled wheels, the engine throw-over is bound to exceed considerably that of the tender. In these circumstances the centring force, which arises from the buffers riding up the inclined planes, will try to move the back end of the engine and therefore the front of the tender over towards the outside rail. Further movement will be prevented when the leading tender wheel bears hard against the outside rail. In consequence there will be a tendency to undue flange wear on these wheels on curves.

In practice it is impossible to set the inclined planes at a steep angle, and in view of the small degree of inclination which is provided, neither the centring effect on the engine nor the additional flange forces on the tender wheels are of great magnitude. If, on the other hand, the buffer springs on each side of the horizontal centre line are independent of one another, the buffer above the inner rail on a curve will be compressed and a force will be exerted on the back end of the engine, tending to rotate its front end towards the outer rail. This will also act against the bogie control spring and, in order to counteract it on curves, the strength of the bogie control will have to be increased for a given leading coupled wheel flange force.

Ready-Mixed Concrete

According to particulars received by us from the Cement and Concrete Association, arrangements have been completed for the inauguration this month in Nottingham of ready-mixed concrete, a new industry for the Midlands, to be distributed by Trent Gravels, Ltd., of Attenborough, Notts.

The principle of "truck-mixed" concrete is to produce laboratory-mixed concrete in the field by supplying directly to the site of the work the required

quantity of concrete containing the correct amounts of ingredients to meet any given specification, ready mixed for immediate use on arrival at the site. It is hoped, by this method, to give a much-needed service to contractors by eliminating the mistakes which are liable to take place when the concrete is mixed on the site. As the materials will be batched by dry weight, consistent strengths and workability can be maintained throughout the job. The scheme will also enable the contractor to effect a saving in labour by employing in placing and spreading the concrete those men who would normally be operating the mixers. A further advantage is that unnecessary handling of materials and encumbrance of the site is avoided.

2½-CUBIC YARD LORRY FOR READY-MIXED CONCRETE

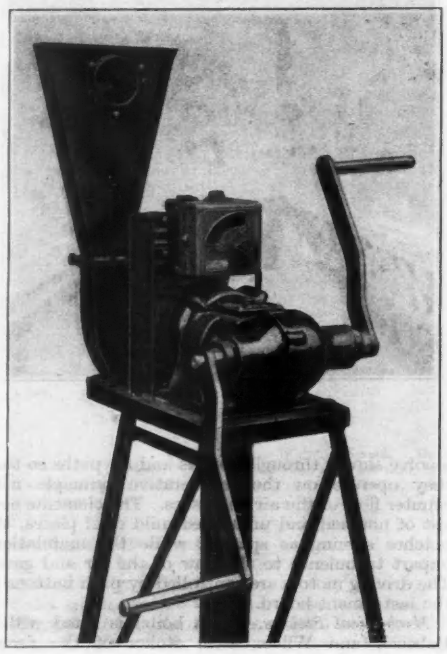
At the Attenborough works of Trent Gravels, Ltd., the new central batching plant has been erected by Ransomes and Rapier, Ltd., of Ipswich, under the supervision of Messrs. Underwood and Cartwright, consulting engineers, of Derby. The scheme also includes a fully equipped laboratory with facilities for the testing and checking of materials, which is being organised under the supervision of Mr. R. H. Harry Stanger, A.M. Inst. C.E. British Portland cement will be used for all concretes.

Six new E.R.F. lorries, with 2½ cubic yard capacity mixers mounted thereon, will start the service, carrying the materials from the batching plant to the various sites; but it is envisaged that the demand for the ready-mixed concrete will grow, and that this number will be increased. The accompanying engraving illustrates one of the special lorries. The practical and economical range of the new scheme will be up to a radius of 25 miles from the central batching plant. On reception of a telephone order for concrete, dry materials will be placed in the mixer and the lorry will leave the batching plant for the site. At a given time or distance from the job the mixer will be set working by the driver of the lorry and water added from a separate compartment so that on arrival at the site the concrete will be ready for placing.

Fans for A.R.P.

To meet ventilating requirements in connection with air raid precautions, Davidson and Co., Ltd., of Sirocco Engineering Works, Belfast, are manufacturing "Sirocco" fan units, suitable for electric operation or for hand operation, should the electric supply fail. These machines are rated in accordance with Home Office requirements to ventilate air raid shelters capable of accommodating 25, 50, or 100 persons. As shown in the accompanying half-tone engraving, the fan unit comprises a centrifugal "Sirocco" fan of 9in. diameter, complete with suction inlet and *evasé* discharge outlet, an electric driving motor and starting switch, and bevel speed-increasing gear, provided with one or two cranks for hand operation. Made in three sizes, with duties of 65, 125, and 250 cubic feet per minute, against a suction head of 4½in. water gauge, the fans require motors of ¼, ½, and ¾ H.P., respectively. In each case the fan revolves at 2800 r.p.m., the corresponding speed of the crank handles being 50 r.p.m. The two smaller sizes can be supplied with only one crank handle, if required, or without electric driving motors, if hand operation only is desirable.

To support the complete unit at a convenient height an angle iron framework is used. The fan casing is of sheet steel welded construction, and the fan wheel is mounted on the extended spindle of the driving motor. So that the air can be drawn through a poison gas filtration unit, the fan suction inlet is spigoted for attachment thereto; but the fan can equally well be operated with or without the filter, as we are informed that the fan speed is sufficient to overcome the extra resistance to air flow when the filter is fitted. The discharge outlet is flanged for attachment to ductwork. As an extra fitting, an air flow indicator can be provided in the discharge casing.



FAN FOR A.R.P.

American Engineering News

Concrete Base for Railway Track

Two applications of concrete as a base for track construction on American railways have employed entirely different methods. In one case, precast slabs, 10ft. by 14ft. and 8in. thick, were laid for half a mile on a high embankment approaching a bridge on the Illinois Central Railroad. In the other case, broken stone deposited and levelled to 12in. thickness was thoroughly grouted to form a concrete slab, 10ft. wide, for each line of rails, the slabs being 800ft. long and 3ft. apart. In both cases the purpose was to stabilise the track and reduce the expense for continual adjustment of line and level made necessary by loose filling and water content on the embankment, and by wet clay soil in the other case. Reinforcing steel was used in the slabs, but not in the grouted concrete. The slabs, made at a neighbouring goods yard, were hauled to the site on flat or platform cars and unloaded by a 30-ton locomotive crane. The track was jacked up and the formation level prepared ahead of the crane. About twenty slabs per hour was a good record. Transverse joints were filled with a mixture of sand and hot pitch after which a bed of 10in. of slag ballast was laid and the track adjusted upon it. For the grouted ballast on the Pennsylvania Railroad, the wet and sticky clay of the formation level was excavated to a depth of 2ft. below the bottom of the ties or sleepers, and side forms were set for the stone, which was from 1½in. to 2½in. size, unloaded from cars and deposited by grab-bucket cranes. After being levelled and tamped or packed, grout was applied by a 2½in. hose connected to a tank supplied by concrete mixers on a construction train. Two men with brooms spread the grout to fill the voids, while others tamped it with a heavy wooden rammer. The top surface was left rough and after three days, the track was replaced, with 12in. of stone ballast under the ties.

Progress in Welding

In the production of strip steel, it has been stated by an American engineer that an electrolytic installation will increase the speed of pickling in any grade of steel. The speed of feeding coils into the pickling lines is being increased, and the time required for welding and trimming the coils is being decreased. Speeds range from 120ft. to 200ft. per minute, and have even reached 240ft. Electrolytic pickling reduces the deposition of pickle salts on the surface of the sheet, and gives a more uniform surface. . . . In the welding of wide strips or sheets end to end, there is a difficulty in the time consumed in welding and stripping, with possible distortion and irregular welding. This may be serious in view of the more rapid pickling by the continuous process. In a new machine designed to overcome this difficulty sheets up to 6ft. 6in. in width and ¼in. thick may be welded in two minutes. The coiled stock from the hot mill is entered between rollers, which level it and remove most of the scale for good contact with the welding dies. The end of the sheet is cropped and then gripped by pincher rolls, which feed it into the welder, while centring mechanism puts the sheet into alignment by side pressure before it is clamped between the welding dies. With the release and raising of the dies, the sheet is raised by a set of rolls, so as not to drag on the face of the die as it is fed forward. . . . In production welding a development is the mass production of all-welded hulls for tug boats and plain and drop-bottom barges. Hull sections are welded in a well-equipped shop and conveyed to an assembly platform at the head of the launching ways, where the sections are welded together and the completed hull is launched sideways. A river tugboat with single screw and 350 H.P. engine has the hull made in three 35ft. sections, requiring only two welds in the open air to form the hull. The shop is 200ft. long, with 63ft. bay for preliminary welding, and 95ft. bay for erection welding. Of 274 hulls, only fifteen were riveted, all the others being welded.

Enlarging a Concrete Dam

With the enlargement and 86ft. increase in height of the O'Shaughnessy Dam on the water supply system of San Francisco, the structure has been completed to its original design and the storage volume increased some 75 per cent. Its height is now 430ft. In the initial construction in 1923 the full section was built up to a height of 118ft., where the thickness was 240ft. Above that there was an offset of 80ft. on the downstream side, and the dam was carried up to its temporary height of 344ft. It is a curved dam with a face radius of 700ft. and a length of 600ft. on the crest, and the original downstream face was stepped in order to facilitate bonding with later work to increase the thickness, which averages about 50ft. In the work of enlargement the object was so to bond the new and old concrete that a completed structure would act under stress as if it had been built as a homogeneous mass of full section. Thus it was necessary to give the new concrete the same strength and modulus of elasticity as the old one, and to provide for adequate distribution of stress. Artificial cooling of the new concrete was a special feature. This concrete was not poured in contact with the old face, except for ribs 2ft. wide, which support the weight of the enlargement. Spaces about 5ft. thick and 20ft. wide were left between the ribs and were concreted after the main mass had cooled, being so shaped or dovetailed as to key the new and old work together. For cooling, horizontal pipes, 1in. in diameter, were placed 5½ft. apart in each 5ft. of height, and water cooled to a specific temperature in a refrigerating plant was pumped through these pipes. Each 5ft. lift or layer was poured not less than seventy-two hours after the preceding lift, and as soon as pouring was completed sprinklers were used to keep the fresh concrete surface wet. The concrete was made with stone of four graduated sizes, and had a slump of 1½in. to 2in., with a minimum strength of 2500 lb. per square inch at twenty-eight days. The cost of the work was about £700,000.

CENTRAL ELECTRICITY BOARD.—The Central Electricity Board has adopted, without modification, the Electricity (Alteration and Extension) Schemes for South-East England, South-West England and South Wales, and North-East Eng nd, details of which were published on June 16th. Copies of the schemes are now available.

New Boiler Plant at Dalmarnock Power Station*

By W. E. YOUNG†

(*Continued from page 84, July 21st*)

Boiler Casings.—Above the water walls the boilers are encased with steel plates, generally ¼in. thick. Nearest the plate there is a ½in. space followed by heat-insulating material, 2in. thick, and inside that again fire-brick 9in. thick in way of the furnace, but reduced in thickness in stages following the gas path to 2in. tiles in the flues leading to the economiser.

Preliminary Heating Arrangements.—Interconnecting pipes and fittings are provided so that steam can be admitted through an injector to draw water from the bottom of the water drums and discharge it into the steam drum. This enables the cold water to be raised to a high temperature before the fires are lit up and avoids the gases, and particularly the products of incomplete combustion, impinging on boiler surfaces which are cold, a common source of fouling of the exterior of the pressure parts.

Superheaters.—The superheaters are of the M.L.S. inter-controlled type, each divided into primary and secondary sections with a combined heating surface of 7750 square feet, 4900 square feet in the primary and 2850 square feet in the secondary section. The tube elements are of the multiple loop type, the primary 1⅞in. and the secondary 1½in. external diameter and both 7 S.W.G. thick. The forged steel headers are 10in. bore, 1½in. thick, with a blind wall between the primary and secondary sections, and to these headers the tubes are connected by metal-to-metal ball joints.

Interposed between the primary and secondary superheaters is a surface type desuperheater, having an upper forged steel vessel, 2ft. 2½in. external diameter and a cast steel base coupled to it by a Vickers-Anderson joint. The desuperheater tubes are 2in. external diameter and the cooling surface 250 square feet. Steam passes through the interior of the desuperheater tubes and on the outside of the tubes boiler water is maintained by means of a down pipe from the boiler steam drum, steam generated passing to the boiler through an up pipe. Two butterfly valves are provided in the steam connections, one in the desuperheater by-pass pipe and the other in the pipe leading to the desuperheater, and by means of these the proportion of steam passing through the desuperheater, or through the by-pass, is controlled, as shown diagrammatically in Fig. 6. The

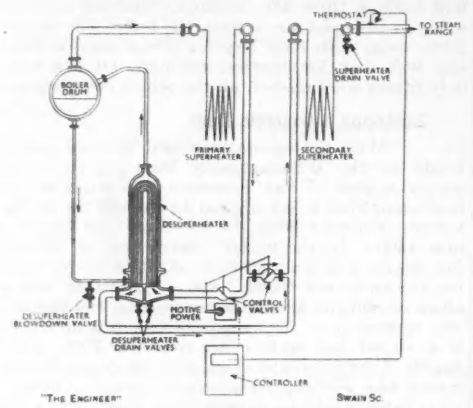


FIG. 6—*Arrangement of Superheater Control*

action of these valves is determined by the steam temperature at the exit from the secondary superheater by means of a thermometer connected by a capillary tube to a spiral Bourdon tube, the whole being filled with mercury under high pressure. The Bourdon tube operates a controller comprising two separate electrical contacts, which in turn energise reversing contactors controlling an electric motor which operates the butterfly valves through gearing so arranged that when one valve opens the other closes. A hand wheel is also fitted to this gearing for direct manual operation, and switches for manual control of the electric motor are also provided at the instrument board. A raise-lower switch is provided, by means of which the automatic control can be cut out, and coloured pilot lights show the direction of rotation of the valve-operating mechanism, either when automatically or remotely controlled. Complete control of the whole apparatus from the instrument board is available by means of a three-way switch, giving immediate change from automatic to push-button or manual control.

Combustion Chambers.—The combustion chambers (Fig. 7) are of the "archless" type with Bailey type water-cooled walls on all four sides having an effective heating surface of 1320 square feet for each boiler. Each water-cooled wall, front, sides, and rear, consists of an upper and lower header which are connected by a number of 3½in. wall tubes. The lower headers are supplied with water by down pipes from the steam drum, four 3½in. pipes for the front wall, two 3½in. for each side wall, and four 4in. for the rear wall. The upper headers are connected to the steam drum by up pipes, four 4in. for the front wall, two 3½in. for each side wall, and four 4in. for the rear wall. The upper and lower headers in each wall are also connected to one another by re-circulating pipes, eight 3½in. for the front wall, four 3½in. for each side wall, and eight 4in. for the rear wall. The circulation in each wall is therefore integral with that in the boiler. The sizes given are the outside diameters of the tubes and pipes.

In the lower parts of the side walls and at the nose of the front and rear walls the blocks are faced with refractory material to maintain the furnace temperature in this region and ensure complete combustion within the furnace.

In the front and rear walls a large number of small secondary air nozzles are placed to supply air for the combustion of the volatile hydrocarbons and to provide for the satisfactory combustion of a wide range of fuels.

Economisers.—The economisers are of the Foster type, each having an external heating surface of 16,300 square feet, made up of 247 horizontal tubes, 22ft. long, arranged nineteen high, thirteen wide. To suit the general lay-out of the plant the gases pass upwards through the economisers, and to provide a measure of counter flow while still maintaining upward water flow, the water is arranged to pass through the upper ten rows of tubes before entering the lower nine rows. The water passes through the thirteen tubes in each row in parallel and from one row to the next through semi-circular bends, jointed to the tubes by lens ring joints. The tubes are of steel, 1½in. internal diameter, 3 S.W.G. thick, and on them cast iron sleeves are shrunk.

Air Heaters.—Each boiler is equipped with two Howden-Ljungström, air preheaters, each operating in parallel and having a surface of 9360 square feet, *i.e.*, 18,720 square feet per boiler. The elements

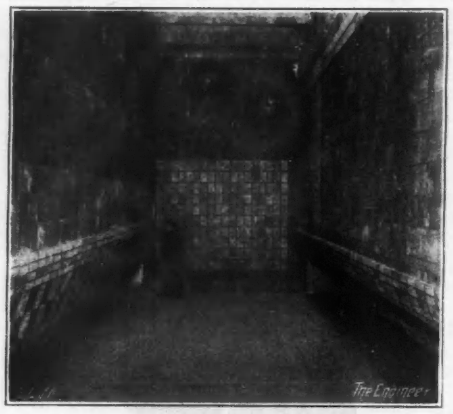


FIG. 7—*Interior of Furnace*

revolve slowly through the gas and air paths so that they operate on the regenerative principle with counter flow of the air and gases. The elements consist of notched and undulated mild steel plates, the notches serving as spacers, while the undulations impart turbulence to the flow of the air and gases. The driving motors are controlled by push buttons at the instrument board.

Mechanical Stokers.—Each boiler is fitted with a Babcock and Wilcox twin stoker of the forced draught compartmented type, 28ft. wide by 18ft. long, having an effective grate area of 504 square feet. The stokers have small and narrow grate links which promote even distribution of air to the fuel bed. The links are of the drop type and are so arranged that in passing over the rear of the stoker a definite movement is given to alternate links across the width of the stoker. This scissor-like action effects the removal of the ash from between the links.

Coal Chutes.—For each boiler the bunker bottom is formed into four hoppers, and four circular chutes, 12½in. internal diameter, lead from these to the stoker hopper, the lower portion of each chute being of partial conical shape to prevent segregation.

Fans and Dust Collectors.—Each boiler is equipped with two forced draught, two induced draught, and two secondary air fans. The forced draught fans are of the single-inlet turbovane type, each designed for an output of 43,500 cubic feet of air per minute at 5·6in. water gauge at 70 deg. Fah. The fan blades are of the backward-thrown type, the impellers being 53in. diameter.

The induced draught fans are of the double-inlet turbovane type, with scroll inlets, each designed to handle 65,000 cubic feet of gases per minute at 7·45in. water gauge, and at 290 deg. Fah. The blades are of the radial tip type and the impellers are 55½in. diameter. Both forced and induced draught fans are driven by two-speed motors running at 970/725 r.p.m. and Tate electrically operated torque units with push buttons at the instrument boards to control the vanes.

The secondary air fans are of the single-inlet type, each designed for a capacity of 8900 cubic feet of air per minute at 12in. water gauge and at 300 deg. Fah. The blades have semi-radial tips and the impellers are 41½in. diameter running at 1440 r.p.m.

The fan shafts are of such a diameter that the lowest critical speed is at least 50 per cent. above the maximum running speed. The movable vane method of regulation of output gives a range of from one-quarter to full load. The fans are capable of dealing with rather more than normal boiler output when running at the low speed of the motors.

Scroll type dust collectors placed on the inlet sides of the induced draught fans are provided with slots at several points around the periphery; through these slots the dust-laden gases are led to secondary vortex cells and from these the dust is led through pipes to the water troughs in the basement, while the freed gas is returned to the centre of the inlet scroll. The volume of gases diverted to the secondary cells is about 10 per cent. of the total volume handled by the fans.

Chimney.—Each boiler has a separate self-supporting steel chimney, 8ft. 6in. internal diameter, the base resting on the fan floor and the top 150ft. 1½in. above ground level. The base is fitted with a conical hopper from which a dust pipe is led to the water troughs in the basement. The chimneys are lined with reinforced concrete, 1½in. thick.

Boiler Mountings.—The following are the more important mountings on each boiler:—One 10in. parallel slide main steam stop valve with a 1in. by-pass valve; one 10in. main steam automatic isolating valve with dashpot; seven 2½in. high-lift safety valves, five on the boiler and two on the superheater; two 5in. feed inlet combined stop and non-return valves; the usual water gauges, blow-off valves, high and low-water alarms, &c.

The safety valves open to the full bore and have a capacity of about five times that of an ordinary spring-loaded valve of equal bore. The valves on the boiler drum are set to lift at a pressure of 695 lb. per square inch and those on the superheater at 645 lb. per square inch. The superheater drain valves are of new type, designed to meet the onerous conditions. Each valve actually comprises two valves in one body, separately operated, a master valve and a regulating valve, which are interconnected so that the master valve must be open before the regulating valve is operated, and the regulating valve must be closed before the master valve can be closed, thus ensuring that the master valve can be operated only when no flow is taking place.

Feed Regulators.—In the feed delivery pipe to each boiler a 5in. Copes regulator is fitted, of the type operated by a single-expansion tube thermostat, and incorporating a spring device for axial movement to compensate for the varying differences in pressure in the feed range and in the boiler. The valve has V-shaped ports, while the ports on the sleeve in which it operates are rectangular.

Soot Blowers.—One of the most vital requirements in modern power stations is the ability to operate boilers for long periods without shutting down for cleaning. In consequence, the type and arrangement of soot blowers receives great attention, as also does any other factor affecting this requirement, such as the preliminary heating arrangement referred to above.

Each boiler at Dalmarnock has five Clyde single-nozzle blowers for the furnace (one in each side wall and three in the front tube bank), four for the second and third tube bank passes, and four for the last pass. In addition, there are eight blowers for the economiser, and blowers for the air preheaters. Steam to these blowers is taken from the outlet of the primary superheater at approximately 650 lb. per square inch pressure and 790 deg. Fah. Under the conditions existing at Dalmarnock this equipment has been found to give very satisfactory results.

Piping and Steam Receivers.—The high-pressure piping follows normal lines. An independent lead is taken from each superheater outlet to one of two steam receivers. These pipes are 10in. bore, ½in. thick at the bends, and ⅜in. thick for straight lengths, the steam speed being calculated at 120ft. per second. Expansion is allowed for by loops, bends, and long arms to give the required degree of flexibility, and gaps of about half the amount of the estimated expansion were left between the flanges during erection. From the steam receivers to the farthest boilers the expansion of the pipes is about 6¼in.

The two steam receivers are of solid forged steel, tensile strength 30–35 tons per square inch, each 3ft. 6in. internal diameter with a wall thickness of 2 $\frac{9}{16}$in., increased to 4in. around the end openings. The nozzles are secured by welding. Each receiver weighs about 14 tons and is anchored at one end, with a roller support at the other end to provide freedom for expansion. Between the two receivers, two cross-over pipes, 12in. bore and 1in. thick, are provided, which enable either turbo-alternator to receive steam from any one or more of the boilers.

The feed delivery piping consists of two ring mains, 8in. bore and $\frac{29}{32}$in. thick, with branches 5in. bore and ½in. thick, delivering to the economisers or direct to the boilers. The usual equipment of blow-down and drain pipes is fitted and does not call for comment.

The larger high-pressure pipes have joints of the seal-welded type with bolts for mechanical strength and welding for tightness. Alloy steel stud bolts are

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† Director, Yarrow and Co., Ltd.

used for steam pipe flanges and mild steel bolts for feed delivery pipes. For suspension of the main steam and feed ranges, where considerable vertical expansion occurs, genspring supports are used, as these provide a constant support over a wide range of vertical movement.

Coal-handling Plant.—The scheme for supplying coal to the new boiler-house (Fig. 8) takes into account the following conditions :—

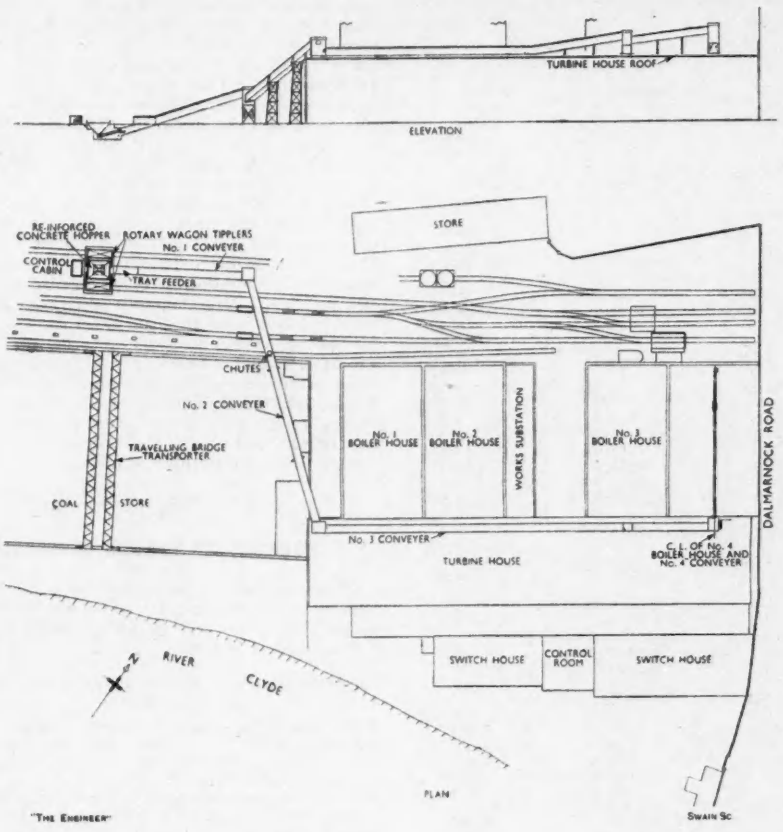
(1) The new boiler-house is remote from the existing 70,000-ton coal store.

(2) Access by siding to the north end of the new boiler-house is restricted and hoists for No. 3 boiler-house overrun the new boiler-house.

(3) Continuous supply by the existing method to Nos. 1, 2, and 3 boiler-houses has to be maintained.

(4) An alternative method of serving No. 3 boiler-house is to be provided.

Fuel can be received from wagons, delivered into the store, reclaimed from the store, and delivered



Item.	Width, in.	Speed, ft. per min.	Motor, H.P.
Rotary wagon tipplers (side discharge)	—	—	25
Tray feeder	42	67	12
No. 1 conveyor	36	300	40
No. 2 conveyor	36	315	40
No. 3 conveyor	36	320	40
No. 4 conveyor	30	325	12

FIG. 8—*Arrangement of Coal-handling Plant*

to No. 4 boiler-house, and if a new conveyor is fitted over No. 3 boiler-house that also can be supplied. Belt type conveyors are employed and with coal of pearl size or fines the capacity is 300 tons per hour for conveyors Nos. 1, 2, and 3, and 200 tons per hour for No. 4.

Two side-discharge rotary tipplers discharge into a concrete hopper of 50 tons capacity, each tippler being weighed full and after emptying. Weighing machines and controls are placed in a single cabin with full view of the operation.

Coal is discharged from the hopper to a tray feeder, the rate of flow being controlled by a sliding door. The feeder discharges to No. 1 conveyor, which rises at an angle of 17 deg. to a height of 28ft. above ground level, where the coal is transferred to No. 2 conveyor. This conveyor rises to the roof of the turbine house and on its way passes between the upper and lower runs of the existing gravity bucket conveyor, where a fixed tripper is arranged on the new conveyor. Coal can be taken to No. 2 conveyor from the coal store by the upper run of the gravity bucket conveyor. By means of a valve on the fixed tripper coal can be taken from No. 2 new conveyor through a chute to the lower run of the existing bucket conveyor and thence to the coal store. At its top end No. 2 conveyor discharges on to No. 3 conveyor, which runs over the turbine house roof. There is a fixed tripper and valve. Where it passes the end of No. 3 boiler-house and there discharges to No. 4 conveyor, which runs over the bunkers in No. 4 boiler-house. A travelling tripper discharges coal through a breeches chute to the bunker. Power to move the tripper is provided by the conveyor belt.

Nos. 1, 2, and 3 belts are 36in. wide, while No. 4 is 30in., the speeds being 300–325ft. per minute. Each conveyor is electrically interlocked so as to start and stop in sequence, and push buttons are provided at intervals along the conveyors for quick stopping. The total length of the conveyors is about 950ft. and the coal is elevated 81ft.

Ash-handling Plant.—Under each line of three boilers there is an ash trough and a separate trough for conveying the dust and grit discharged from various points in the boiler system. The ash troughs are 2ft. wide and the dust troughs 15in.; both are inclined at an angle of 1 in 50 and discharge into a swirl pit outside the north end of the boiler-house. Either of two 8in. horizontal lined ash pumps, each having a capacity of 2500 gallons per minute of water against a head of 58ft., draw ash-laden water from the swirl pit and discharge into a concrete storage hopper which is divided into two sections, each with a capacity of 7000 cubic feet. These sections are used alternately, so that when one is being filled the ash in the other can be drained and discharged. The water overflows from the storage hoppers near the top and returns to the troughs, so providing a continuous circulation of water without wastage except for the small amount discharged with the ash. A discharge door at the bottom of each section of the storage hopper allows for final drainage of the ash before discharge. The water so drained passes to the reserve tank to supply water for one section of the storage tank before the ashes are pumped into it, thus ensuring continuity of flow down the troughs when the discharge of ashes from the pump is changed over from one bunker section to another.

Electrical Equipment.—All the motors in the boiler-house are arranged for starting direct on the line and to develop their full rated output at any voltage between 440 and 300 and at any periodicity between 50 and 45 cycles per second. The fan motors are directly coupled to the fans through flexible couplings those for the forced and induced draught fans being of the two-speed type. The installation includes the following :—

For induced draught fans : twelve motors, each 175/76 B.H.P. at 970/725 r.p.m.

For forced draught fans : twelve motors, each 62/27 B.H.P. at 970/725 r.p.m.

For secondary air fans : twelve motors, each 29 B.H.P. at 1440 r.p.m.

For ash pumps : two motors, each 100 B.H.P. at 585 r.p.m.

For stokers : twelve motors, each 3½ B.H.P. at 900 r.p.m.

For preheaters : twelve motors, each 2½ B.H.P. at 960 r.p.m.

For vane control : twenty-four internally geared motors, each ¼ B.H.P. at 85 r.p.m.

The ash pump and stoker motors are controlled by hand-operated oil-immersed "direct-on" starters. All the other motors are controlled by contactor type starters, operated by push buttons on the instrument board. Coloured lights indicate which motors are running, and at which speed they are running, and dial indicators show the position of the vanes.

For the coal-handling plant there are the following motors :—

For the tipplers : two motors, each 25 B.H.P. at 720 r.p.m.

For the apron feeder : one motor, 12 B.H.P. at 720 r.p.m.

For Nos. 1, 2, and 3 conveyors : three motors, each 40 B.H.P. at 960 r.p.m.

For No. 4 conveyor : one motor, 12 B.H.P. at 960 r.p.m.

The wagon tipplers are operated by tramway type reversing controls, and limit switches are provided to guard against over-running in either direction. The motors for the conveyors are operated by contactor type switchgear with duplicate push buttons to give either remote control for normal operation or local control at the starters for test provision. The sequence system already referred to is so arranged that on pressing one button all the motors will start in the correct sequence automatically, this being necessary to prevent spilling through one conveyor delivering coal to another conveyor not in operation.

Time for Execution of Contract.—The principal dates were as follows :—

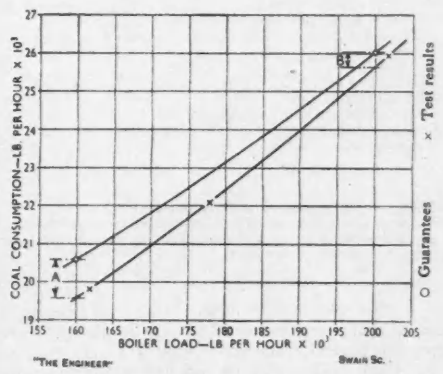
Order placed with Yarrow and Co. as main contractors, December 10th, 1935.
Excavations commenced, May, 1936.
Foundation raft completed, October 12th, 1936.
First building column erected and first boiler structure commenced erection, October 15th, 1936.
First boiler hydraulically tested, March 5th, 1937.
Fires lit in first boiler, August 31st, 1937.
First two boilers on full load, November 1st, 1937.

As the time for erection was short, especially on account of the difficulty of obtaining prompt delivery of material during this period, the building and the boiler plant were erected concurrently and in three stages, each comprising one-third of the building and one pair of boilers with auxiliary plant.

To expedite the work, four cranes were installed : a 7½-ton travelling jib crane on the sidings to the north, a 5-ton derrick crane in the yard to the north, a 10-ton derrick crane on the foundation raft, and a 5-ton derrick crane on the roof. The last two cranes were used in three positions, one for each of the stages referred to above. The heaviest lifts were the steam drums, which weighed nearly 30 tons each, and the most difficult lifts were the coal bunker girders, weighing 20 tons each.

TEST RESULTS

The official tests were carried out on March 21st and 22nd, 1938, and the results are given in the accompanying tabulation. The coal used was a mixture of Lanarkshire washed pearls and singles, 20–25 per cent. of which passed through a ¼in. diameter mesh. The efficiencies given are in all cases based on the gross calorific value of the fuel as fired, and are considerably higher than the guarantees. A comparison of the fuel consumption with the guarantees is indicated in Fig. 9, A and B being the amounts



— Guarantees × Test results

FIG. 9—*Fuel Consumption Curves*

by which the guaranteed consumptions were improved upon at normal load and maximum continuous rating respectively.

For the tests a temporary platform was erected at the level of the stoker hoppers and four temporary chutes were provided to discharge coal from the bunkers to these platforms. Four certified coal weighers were placed on the platform and the coal was weighed in this way. The only part of the system with a sufficient length of straight piping to accommodate a water meter was the combined feed pipe in the turbine house. A certified meter was fitted at this point, but this necessitated one boiler only being in operation during the tests, and owing to the reduced turbine load the temperature of the feed water was considerably lower than that on which guarantees were based. The actual efficiency figures obtained on the tests therefore had to be adjusted downwards, as shown in the table, in order to compare them with the guarantees. The adjust-

ment was made by calculating the gas temperature drop in economiser and air heater, allowing the same rate of heat transfer per degree of mean temperature difference.

Separate tests run at an evaporation rate of 100,000 lb. per hour proved that the steam temperature at that load was not lower than 825 deg. Fah.

OPERATING NOTES

Some observations on experience with the plant in service may be of interest :—

(1) Although the furnace setting is of the arched type, where instability at low loads is sometimes experienced, it was found that conditions were quite stable at evaporation rates as low as 8000 lb. per hour.

(2) Three methods were allowed for in the design for adjusting the steam temperature, should this be found necessary : increasing or decreasing the surface of the tube bank screening the superheater from the furnace, increasing or decreasing the superheater surface and adjusting the gas baffles at the top and bottom of the superheater. Only one was utilised, the baffles which were intentionally omitted when first starting up having to be put in place. Thereafter the steam temperature was up to guarantee.

(3) Each boiler unit can be steamed continuously at a load of 230,000 lb. per hour, but above that load the feed regulators, as at present set, would not pass sufficient water with the pressure provided in the feed mains.

(4) The method of operation of the soot blowers found to give satisfactory results is once in eight hours for the furnace, once in twenty-four hours for the rear boiler banks and economisers, and once a week for the air heaters. At first small throat pieces, 1in. diameter, were fitted in the front furnace blowers, but these were later enlarged to 1⅛in. diameter, and under these conditions steaming at full output for periods of 2000 hours is possible without any sign that hand cleaning is necessary, and steaming has actually been continued for considerably longer periods.

(5) Dust discharge from the dust separating plant amounts to about 2 cwt. per hour per boiler.

(6) Dust collected in the hopper formed by offsetting the flue between the economiser and the air heaters is about 1 ton per week per boiler.

(7) To compensate for the growth of the stoker links after nine months' service, one link out of 235 has been removed.

(8) The feed regulators work well provided the clearance of the valve in its sleeve is 7/1000in.; with less clearance there is an inclination to sluggishness.

(9) Probably owing to the space between the two valves in the 8in. parallel slide valve on the feed service being closed to hydraulic pressure, these valves under certain conditions cannot be opened or shut unless a small valve is fitted to that space to relieve excess pressure.

(10) Where spilling of coal cannot be permitted, as in the case of No. 3 conveyor over the turbine house roof, some form of scraper gear is necessary to ensure that particles of coal do not adhere to the return run, particularly in frosty weather.

(11) The most satisfactory way of operating the ash plant is to have a continuous discharge and not to open and shut the ash hopper doors periodically.

(12) Based on 1 per cent. heat loss by radiation, the temperature of air entering the forced draught fans would be raised by 40 deg. Fah. The only place where air could be admitted at a low level to the house was at the north wall, and openings were made there below the firing floor. A continuous narrow opening with grid covering was also provided in the firing floor itself at the back of the boilers and running across the south end of the building so as to distribute the air flow as equally as possible on its passage to the fan intakes. On the supposition that the mechanical power of these fans might draw air inwards through any openings in the roof and so reduce the flow of air through the boiler-house proper, no large openings were made in the roof and the partition walls between the fan floor and the space over the bunkers were made tight so as to isolate the ventilators in the roof above the bunkers. Temperature readings, taken in the region of the fans, indicated that the temperature rise, based on 1 per cent. radiation, was approximately correct, but certain spaces under the fan floor, where the air flow was reduced, naturally became hotter than the average. It was also found that the mechanical effect of the fans did not prevent excess air passing upwards through the roof. Openings were therefore made in the partitions leading to the space over the bunkers. To reduce further the temperature in the boiler-house on hot summer days ducts have been connected to the induced draught fan suctions to draw air from the hottest places, these fans having sufficient margin of capacity for this purpose.

(13) The day-to-day efficiency of the boiler plant is about 87 per cent., and operating figures for the new boiler plant as compared with the previous low-pressure low-temperature plant at Dalmarnock show a marked reduction in the labour costs per unit of output. For the same electrical output there is a weekly saving of approximately 1500 tons of coal based on the operation of one new turbo-alternator and three new boilers, equivalent to a saving of 3000 tons per week with the complete new plant in operation. The thermal efficiency of the new boiler plant and turbo-alternator during the first six months of 1938 was approximately 27·3 per cent. based on the units sent out from the station.

The author is indebted to Major Herbert Bell, O.B.E., T.D., for permission to give the particulars contained in this paper, and to Major Bell and members of his staff for kindly providing the information on which the paper is based.

Test Results

Nominal evaporation, lb. per hour	160,000	180,000	200,000
Actual evaporation, lb. per hour	161,852	177,871	201,715
Pressure at superheater outlet, lb. per square inch	627	617	610
Steam temperature at superheater outlet, deg. Fah.	847	846	849
Temperature of water entering economiser, deg. Fah.	264	271	279
Temperature of water leaving economiser, deg. Fah.	364	370	371
Temperature of gases leaving boiler, deg. Fah.	620	633	650
Temperature of gases leaving economiser, deg. Fah.	331	342	354
Temperature of gases leaving air heater, deg. Fah.	209	218	220
Temperature of air entering air heater, deg. Fah.	90	95	86
Temperature of air leaving air heater, deg. Fah.	219	225	224
Coal burned, lb. per hour	19,067	20,800	24,533
Evaporation per lb. of coal, lb.	8·49	8·55	8·22
Coal burnt per square foot of grate area, lb.	37·84	41·28	48·67
Calorific value of coal as fired, B.Th.U. per lb.	11,310	11,500	11,410
Fixed carbon, per cent.	48·96	48·51	49·13
Volatile matter, per cent.	28·16	30·61	30·23
Ash, per cent.	7·58	7·12	7·02
Moisture, per cent.	15·3	13·76	13·62
Hydrogen, per cent.	4·01	4·11	4·13
Ash produced, lb. per hour	752	727	766·8
Combustible in ash, per cent.	3·4	5·9	5·6
Riddlings produced, lb. per hour	27·6	37·1	39·8
Combustible in riddlings, per cent.	15·2	19·0	18·6
CO_2 at boiler outlet, per cent.	13·6	13·4	13·9
CO_2 at air heater outlet, per cent.	12·23	12·0	11·4
Gas suction at combustion chamber, inches water gauge	0·09	0·07	0·06
Gas suction at boiler outlet, inches water gauge	0·6	0·70	0·75
Gas suction at economiser outlet, inches water gauge	1·5	1·8	1·9
Gas suction at air heater outlet, inches water gauge	2·7	2·9	3·0
Air pressure at forced draught fan discharge, inches water gauge	1·95	2·3	2·6
Air pressure under grate, inches water gauge	0·5	0·77	0·95
Secondary air pressure :			
Front, inches water gauge	5·1	5·55	5·4
Rear, inches water gauge	8·5	8·7	8·8
Current consumption of auxiliaries per boiler :			
Induced draught fans, amperes	145	152	159
Forced draught fans, amperes	88	99	104
Secondary air fans, amperes	56	56	56
Air heaters, amperes	5·3	5·3	5·3
Stokers, amperes	5·5	5·5	5·5
Total heat, feed to final steam, B.Th.U. per lb.	1,202·6	1,195·2	1,189·3
Heat transferred in economiser, B.Th.U. per lb.	100	99	92
Heat transferred in boiler, B.Th.U. per lb.	880·6	874·6	873·7
Heat transferred in superheater, B.Th.U. per lb.	220·0	221·6	223·6
Heat transmitted :			
Per square foot of boiler and water wall surface, B.Th.U. per hour	8,254	8,958	10,150
Primary superheater surface, B.Th.U. per hour	4,932	5,947	6,224
Secondary superheater surface, B.Th.U. per hour	5,570	5,522	7,210
Desuperheater surface, B.Th.U. per hour	16,452	21,064	23,312
Economiser surface, B.Th.U. per hour	99·24	1,080	1,139
Air heater surface, B.Th.U. per hour	380·6	433·3	535·2
Economiser surface per degree Fah. of mean temperature difference, B.Th.U. per hour	6·16	6·466	6·45
Air heater surface per degree Fah. of mean temperature difference, B.Th.U. per hour	3·28	3·61	4·05

Heat balance :	B.Th.U.	Per cent.	B.Th.U	Per cent.	B.Th.U.	Per cent.
Absorbed in boiler	10,209·0	90·25	10,220·0	88·87	9,778·7	85·70
Lost in dry flue gases	381·5	3·38	399·7	3·48	448·6	3·93
Lost to moisture and hydrogen in fuel	561·0	4·96	553·7	4·82	559·2	4·90
Lost by combustible in ash and riddlings	22·7	0·20	34·9	0·30	29·8	0·26
Radiation and unaccounted losses	135·8	1·21	291·7	2·53	593·7	5·21
	11,310·0	100·00	11,500·0	100·00	11,410·0	100·00
Efficiency from actual test records, per cent.		90·25		88·87		85·70
Efficiency corrected for specified feed temperature of 320 deg. Fah. and adjusted to nominal evaporation (from curve), per cent.		89·5		87·8		85·25
Efficiency guaranteed, per cent.		85·0		—		84·0

A TYNE IMPROVEMENT SCHEME

AT the annual meeting of the River Tyne Improvement Commissioners, which took place at Newcastle-upon-Tyne on Monday, July 17th, reference was made by Mr. R. S. Dalgliesh, the Chairman of the Docks and Trade Committee, to the plans which have been completed for the construction of a new river-side quay at Tyne Dock, which, it is estimated, will cost about £750,000. The quay, which we mentioned in our Annual Review of Harbours and Waterways of January 6th, 1939, is to have a river frontage of about 1400ft., and a depth of water of about 35ft. at the low water of spring tides, which, the Commissioners hope, will attract large liners to the Tyne. New traffic offices have been built, and the equipment of the dock is being modernised with this end in view. Mr. Dalgliesh said that as soon as approval had been received from the Commissioner for Special Areas, the Ministry of Transport, and the Board of Trade, the matter would again come before the Commissioners, so that tenders for the work could be invited. The new quay at the north-west corner of the dock which is now under construction at a cost of £250,000 would, Mr. Dalgliesh said, be ready for service in the October of next year.

BRITISH STANDARDS INSTITUTION

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

DEFINITION OF CINEMATOGRAPH "SAFETY" FILM

No. 850.—The Committee which was responsible for the preparation of this standard reviewed carefully the work which had been carried out in other countries, and it has adopted the "Lehman test" as the basis. This test was recommended in the report of the Seventh International Congress for Scientific and Applied Photography, and has also been accepted subsequently as the international standard. It is applicable to all film used for cinematograph purposes, that is, both sub-standard film and the standard 35 mm. film. It was realised that the Lehman test, being a laboratory test, required rather a long time for it to be carried out. Further, it necessitated test specimens of appreciable length, the cutting of which from a complete film resulted in a measure of mutilation. The Committee have therefore included a "field test," which can be quickly carried out to give a definite indication as to whether a film can be classified as "safety" or not. It is emphasised, however, that this test should not be used as a test for quality. Further, it is recommended that those whose responsibility it will be to carry out the field test should preferably first have an opportunity of being trained in the method of its application.

BRITISH STANDARD WING NUTS

No. 856—1939. The present issue of this standard is limited to the dimensions of the wing nuts. Whilst some consideration has been given to a simple mechanical test for strength, the details of such a test have yet to be agreed, but it is hoped to include this test in the first revision. The specification deals with two types of wing nuts and appropriate dimensions are standardised for each. The first series of dimensions relates to wing nuts manufactured from hot brass or other non-ferrous stampings, malleable iron castings, and hot steel stampings. The second series of dimensions relates to wing nuts manufactured by cold forging mild steel or brass. In each series nine sizes of nuts are standardised for B.S.W. and B.S.F. threads from ¼in. to ¾in. nominal diameter inclusive, and for B.A. threads Nos. 0 to 5 inclusive.

WELDED STEEL BOILERS

No. 854; No. 855. The specification for steam central heating boilers (No. 854) covers boilers for operation at pressures not exceeding 30 lb. per square inch, and the specification for hot water boilers (No. 855) covers boilers of over 5 square feet heating surface for operation at pressures not exceeding 65 lb. per square inch (150ft. head) or at temperatures exceeding 212 deg. Fah. Both specifications provide for the materials to be used, and give formulæ to be used in calculating the scantlings. Another section covers the requirements with respect to construction and workmanship, full details in connection with the forms of joint to be used, being given. A further section gives the requirements for mountings and other appliances, this being amplified in the steam boiler specification by the inclusion of a clause on pressure gauges.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The Polish Steel Problem

For some time past the International Steel Cartel has been faced with the necessity to readjust the position of some of its members, brought about by the results of the Munich agreement in September last. The Czechoslovakian problem had been settled, but there remained a very important one, namely, Poland, and at the meeting in Liège last week of the Joint Co-ordinating Committee a further step towards the settlement of the Polish question was taken. Following the transfers of the Sudeten territories, Poland and Hungary acquired important tracts of Czechoslovakia. In the case of Poland the steel works at Trinec, close to the Witkowitz works, came into her hands. This works produced about 25 per cent. of the total Czech output and belonged to the Berg und Huttenwerks Gesellschaft, of Prague, in which France had capital interests through the Schneider-Creuzot group. In 1937 the Polish raw steel output was over 1,000,000 metric tons, and the output of the Trinec works approximately 250,000 tons. Before Munich, the output found a ready sale in the Czechoslovakian home market, but following the German acquisitions in Czechoslovakia much of this trade has been lost to Germany. Thus Poland was faced with a material increase in her steel output capacity, and no market for it. This in turn meant that Poland must expand her exports and to do so had to apply to the Cartel for an additional export quota. For a time the other members of the Cartel agreed to allow Poland to take a limited tonnage of orders in excess of her existing export quota, subject to some definite mutual arrangement being arrived at later. Under the arrangement come to at the meeting in Liège last week the Trinec works will manufacture semi-finished steel for disposal among the other Polish rolling mills. They in turn will manufacture the semis into finished products, which they will export to markets over which the Cartel has at present no control, thereby causing no disturbance to the present Polish official export quota. What will be the repercussions to this decision it is difficult to say. Nominally most of the important world consumers of iron and steel, outside Russia, the United States and certain parts of the Far East, are under the Cartel control, so that the outlet for the Polish exports is likely to be somewhat restricted.

The Pig Iron Market

The pig iron market in general shows little change this week. Foundry iron is still the least active section, and makers are producing only enough to meet consumers' urgent requirements. The demand for hematite continues steadily to improve, and buyers are contracting for larger quantities than they have been taking in the past few months. A small volume of export trade to Continental users is also maintained by merchant houses with long-standing overseas connections. Full production of basic pig iron continues, almost all of which is taken up direct by steel works. On the North-East Coast the furnaces continue to turn out large tonnages of basic pig iron, but the whole of this is going direct into consumption, and there is none available for the open market. In this district the demand for hematite is making steady progress, and makers are able to report considerable inroads on their large stocks, although the call for deliveries has not yet come right up to expectations. Most of the business is, of course, of a direct nature, but merchants are fairly active, and on occasion are able to sell a little for export. At Scunthorpe the largest blast furnace in this country has just been lit at the Appleby-Frodingham Steel Company's works. The furnace has a weekly output capacity of 3,500 tons. A second similar furnace is due to be put into commission in a few weeks time. The market for Cleveland foundry pig iron generally is still quiet, and though makers' stocks are small they feel there is no need to increase the output. Export business in foundry grades is virtually absent. In the Midlands low phosphorus grades of foundry pig iron are being consumed in regular quantities, but high-phosphorus iron is not moving any too freely, as up to the present there is no sign of a revival in the demand from the light castings industry. Some business has been done, however, for delivery over the ensuing weeks. North-East hematite producers are somewhat apprehensive that their trade with the Clyde will suffer as a result of the agreement between Colvilles and Barrow Hæmatite, whereby the heavy mills of the latter will cease to operate for ten years. In Lancashire the demand for pig iron is still maintained at a steady rate, machine toolmakers in particular being heavy buyers. The electrical industries also are taking up regular quantities, but business with textile machinists is far from active, the export demand for textile plant being well below the level of a year ago. Producers in South Wales are in active employment, and most of their output is going direct into local steel works. In Scotland business has been resumed after the Glasgow Fair holidays. The blast-furnaces, of course, remained in action, and number thirteen. A large tonnage of Australian basic pig iron is expected to arrive in August.

The North-East Coast and Yorkshire

Intense activity prevails in the steel markets in the North-Eastern districts. Government demands are on an unprecedented scale, and as these are now being given priority in regard to deliveries, ordinary commercial users have to wait some time to place new business. Rollers of semis are working to capacity, but even so supplies are insufficient to meet the demand, and are being augmented by heavier arrivals from the Continent under the Cartel agreement, and by imports from Australia. A cargo of 8250 tons of Australian sheet bars, the first of its kind, has just been imported into the Tees. Consumers of sheet bars, in particular, are hard pressed for all their requirements, as the call upon the productive capacity of the sheet works is very high, and many of them have enough orders to keep them fully employed for several months. Most of this demand, of course, is in connection with A.R.P., and large deliveries of air-raid shelters are being made each week. Conditions in the shipbuilding department are improving steadily. Since the Government's announcement of help for this industry, quite a change round has been seen, and within the space of a few months stocks have come back into employment. It is expected that new orders will continue to come along now regularly so that steel makers may expect an influx of orders for shipbuilding steel. Structural steel makers, whose production forms a large part of the output, are also very busy, and in a number of cases cannot accept orders for new business for delivery before the end of October and even beyond, so that new commercial business is inclined to be on the quiet side. Large quantities of small constructional steel are being used in the manufacture of the air-raid shelters. In the Yorkshire district the demand for basic steel billets is unabated, and though the output is virtually at capacity, extended delivery for new business is becoming the rule. In the Sheffield area aircraft steel is being produced in large quantities, and there is also much activity in machine tools and high-precision instruments. General export business is quiet, but some special overseas business has been placed. In the finished iron section, business remains disappointing; and although some improvement has been reported in the demand for marked bars, the mills are only able to operate part time.

Scotland and the North

With the exception of Colvilles Clydebridge Steel Works, which did not close for the holidays, most of the steel works resumed early this week. Opportunities have been taken to effect repairs, and at the Dalzell works at Motherwell certain alterations have been made to the mill rolling large sections. There is no sign of a break in the present activity, which seems assured for some months. Primarily, Government demands absorb the bulk of the output, both in connection with armament and defence, sheet rollers in particular having a vast amount of work on hand. Commercial shipbuilding, however, has been making rapid progress, and these orders, coupled with Admiralty business, will give employment at the yards for some time to come. Recently the Navy has awarded Clyde builders contracts for two minesweepers and other important orders are expected to be given out at an early date. Activity also prevails in the general engineering, structural, and locomotive departments. Boilermakers' order books have been increased by a contract worth close on half a million pounds for water-tube boilers for destroyers belonging to the Greek Navy. Increased business in heavy steel generally is expected next year, when the Barrow Hæmatite Steel Company, under its arrangement with Colvilles, closes down its heavy steel departments for ten years. There is not much improvement to be reported in the manufactured iron industry. Most of the business passing is for small parcels to cover consumers' more immediate requirements. In this section it was to be expected, therefore, that the resumption after the holidays would be somewhat protracted. The motor trade is furnishing a good deal of work to the sheet makers for special quality steel. In Lancashire the steel trade reports a good volume of business. Semis are in strong demand, local consumers of billets and rods calling for good quantities, while additional orders for blooms and billets have come in lately from the forging industries. All sections of the light steel industry are busy, bars being in good request and consumers of structural steel urgently in need of deliveries. Locomotive manufacturers have been placing orders for plates and boilers, while the demand from makers of tanks is also substantial. In the manufactured iron section quiet conditions still prevail. Consumers have bought principally for prompt delivery and have not been displaying much interest in forward business. On the North-West Coast the arrangement between Colvilles and Barrow Hæmatite is considered a serious blow to industry in the district, as it will mean at any rate the cutting down of rail production there by 50 per cent.

Current Business

Henry Robb, Ltd., Leith, have secured an order from the General Steam Navigation Company, London, for a 500-ton cargo motorship and a similar order from James Currie and Co., Leith. The firm is also building two 770-ton motor coasters for the Booth Line. It has been announced that part of the Workman, Clark shipyard at Belfast is to be employed for the production of steel mesh reinforcement for concrete by a company in which George Cohen, Sons and Co., Ltd., London, are interested. The Davy and United Engineering Company, Ltd., engineers and boilermakers of Park Iron Works, Sheffield, is taking over the entire share capital of Duncan, Stewart and Co., Ltd., engineers, of Glasgow. A machine shop and store are being erected in Sheffield Road, Tinsley, for Tinsley Wire Industries, Ltd. Wm. Moyes and Sons, Ltd., acetylene engineers, Glasgow, are erecting a workshop at Cathcart. Jarrow Metal Industries have been awarded an Air Ministry contract involving an expenditure of several hundred thousand pounds for the construction of buildings, plant, and equipment. A new factory is to be erected adjacent to the present one, and the plant is expected to start production within the next seven to eight months. Additional electric furnaces are being erected at the present works. About 30 acres of ground at Barnbow, near Leeds, have been bought by the War Office for the erection of a gun-manufacturing works. The United Kingdom Gas Corporation has arranged with the Yorkshire Coking and Chemical Company for a gas-purifying plant to be erected at Glass Houghton at a cost of £32,000. The Johannesburg Transport Department is recommending the purchase of sixty British motor omnibuses at a cost of about £170,000. It is proposed to construct another new quay at Tyne Dock. It will be 1400ft. long and will cost about £750,000. Balfour Beatty and Co. have been given a contract for flood-stopping work on the Euphrates, near Ramadi, Iraq. The work will cost about £900,000 and will take four years to complete. The scheme is to divert the flood waters about 50 miles from Bagdad and carry them into Lake Halbaniyah, an Imperial Airways base. The Department of Overseas Trade announces that the following contracts are open for tender:—Sydney Posts and Telegraphs Department: Supply and delivery of quantities of channel iron (Melbourne, August 29th). Brisbane City Electric Light Company, Ltd.: Supply and delivery of electricity meters and current transformers (Brisbane, September 5th). Queensland State Railways: Supply and deliveries of workshop machinery, complete with motors (Brisbane, August 10th).

Copper and Tin

The copper market has remained quiet and American producers are now comfortably placed owing to the heavy buying earlier this month. It is doubtless on the strength of this that they have now raised their domestic price of electro to 10·37½c. per pound delivered, though the additional advance does not seem justified by the actual demand. Obviously consumers over there have no need to re-enter the market for large tonnages for two or three months to come. On the international market the quotation has fluctuated between 10·25c. and 10·32½c., c.i.f. Europe. Although home business in America has been distinctly quieter, fair export sales are still being effected. The labour trouble at important automobile works, of course, tends to restrict consumption; but general business sentiment over there seems to be improving. American figures give the world stocks of refined copper on June 30th at 513,670 short tons, compared with 520,898 on May 31st. The stocks in the United States fell from 337,155 tons at the end of May to 335,012 tons on June 30th, and the stocks elsewhere from 183,743 tons to 178,658 tons at the end of June. World output rose from 170,472 tons to 173,205 tons in June and in the United States declined from 68,536 tons to 61,719 tons. Poland is reported to have been showing buying interest in copper of late, possibly in case of trouble over Danzig. On the London market there has definitely been more speculative interest taken, since the impression is growing that in view of the inflationary tendency throughout the world copper prices are likely to rule higher later on. At the same time, bull speculators are not committing themselves too deeply, and it is noticeable that they are anxious to snatch a profit as soon as possible. Any advance in standard prices is swiftly followed by profit taking. Consumption in Europe seems to be proceeding on a good scale, and Japan is reported to be short of supplies. . . . The London standard tin market remains closely under control and cash has ruled for some weeks past at £230 sellers. The Buffer Pool is selling fairly steadily at this price, but consumers on both sides of the Atlantic appear to be limiting their purchases to a minimum. This is not surprising in view of the fact that on top of the present artificially inflated price they have to pay full premiums for their special brands, to which they have become accustomed as a result of works' practice in the past. It is interesting to note that some American consumers are apparently re-selling a little of their stocks in order to secure profits on their holdings; they do not fear doing this because it seems certain that they will be able to buy fresh supplies when they need them at £230. Some comment has been aroused in London by the fact that the premiums payable on special brands on the other side of the Atlantic are lower than those quoted here by holders of prompt parcels. France is reported to be endeavouring to acquire a few thousand tons of tin as a war reserve. The consumption of tin in the U.S.A. during the first five months of 1939 is estimated at 25,020 tons, or almost the same as the deliveries to consumers of 25,075 tons. This suggests that invisible stocks in that country during the period January-May, 1939, were practically unaltered.

Lead and Spelter

Prices of lead on the London market have fluctuated during the past week, but the undertone has been a little less confident than a week ago. Labour trouble at the Trepca properties in Jugoslavia threatens to curtail supplies from that quarter. In Spain production is expanding, but much of this additional output is likely to be needed for domestic consumption or will go to Italy or Germany, and may therefore not come on to the international market in the near future. The supply position in London has become easier, in view of the heavier declarations of both Empire and foreign lead; but it is believed that this metal will be quickly taken up. Although members in the Lead Producers' Association seem to be endeavouring to keep output under control, their task has been made more difficult in recent months as a result of the resumption of operations at the Mexican properties previously affected by prolonged labour troubles. In the United States a good business has been passing with the demand well distributed over the chief consuming industries, and the price is firm at 4·85c. per pound, New York. American figures give the world production of refined lead in May at 169,245 short tons, against 161,587 tons in April. . . . The London spelter market has been somewhat erratic of late, having moved upwards the last few days after a decline. Speculative interest is almost at a standstill, since few people feel any real confidence in the metal at the moment, and better conditions must depend mainly on a general easing of the political tension in Europe and the Far East. The consumption of spelter in connection with the British civil defence scheme remains excellent, but elsewhere the interest taken is disappointing. There was a certain amount of selling of prompt metal during the past week due to somewhat heavier arrivals, without any corresponding expansion in buying interest. In the United States the price is steady at 4·50c. Producers there continue to grumble over the effects of the import duty reduction, as a result of which some mines are being forced to close. American statistics give the world production of zinc in May as 153,692 tons (short), which compares with the April total of 152,491 tons.

Current Prices for Metals and Fuels

Makers' official home trade price, per ton, delivered buyers' stations. *Joists, Sections, Bars and Plates are subject to a rebate of 15s. to home users purchasing only from Associated British Steelmakers. †Export prices are for Empire Markets; for other Markets British quotations conform to Cartel prices.

PIG IRON.

Foundry home prices, except for Scotland, less rebate of 5/-.

(*D/d Teesside Area.*)

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Hematite Mixed Nos.	5 15 0	—
„ No. 1	5 15 6	5 15 0
Cleveland—		
No. 1	5 2 0	5 2 6
No. 3 G.M.B.	4 19 0	5 0 0
No. 4 Foundry	4 18 0	—
Basic	4 12 6	—
Midlands—		
Staffs— (*Delivered to Black Country Station.*)		
North Staffs Foundry	5 1 0	—
„ „ Forge	4 18 0 to £5 0 0	—
Basic	4 12 6	—
Northampton—		
Foundry No. 3	4 18 6	—
Forge	4 15 6 to £4 17 6	—
Derbyshire—		
No. 3 Foundry	5 1 0	—
Forge	4 18 0 to £5 0 0	—
Scotland—		
Hematite, f.o.t. furnaces	5 15 6	—
No. 1 Foundry, ditto	5 3 0	—
No. 3 Foundry, ditto	5 0 6	—
Basic, d/d	4 12 6	—
N.W. Coast— Hematite Mixed Nos.	5 15 6 d/d Glasgow 6 1 0 „ Sheffield 6 7 0 „ Birmingham	

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Lancs and Yorks—		
Crown Bars	12 5 0	—
Best Bars	12 15 0	—
Midlands—		
Crown Bars	12 5 0	—
Marked Bars (Staffs)	15 15 0	—
No. 3 Quality	10 17 6	—
No. 4 Quality	11 7 6	—
Scotland—		
Crown Bars	12 5 0	12 5 0
Best	12 15 0	12 15 0
N.E. Coast—		
Crown Bars	12 5 0	12 5 0
Best Bars	12 15 0	12 15 0
Double Best Bars	13 5 0	13 5 0
Northern Ireland and Free State—		
Crown Bars, f.o.q.	12 17 6	—

STEEL.

	*Home. £ s. d.	†Export. £ s. d.
London and the South—		
Angles	10 10 6	10 0 0
Tees	11 10 6	11 0 0
Joists	10 10 6	10 0 0
Channels	10 15 6	10 5 0
Rounds, 3in. and up	11 10 6	11 0 0
„ under 3in.	11 17 6‡	11 0 0
Flats, under 5in.	11 17 6‡	11 0 0
Plates, ¼in. (basis)	10 15 6	10 2 6
„ 5/16in.	11 0 6	10 7 6
„ ⅜in.	11 5 6	10 12 6
„ 7/16in.	11 10 6	10 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6
Boiler Plates, ¼in.	11 13 0	11 12 6
North-East Coast—		
Angles	10 8 0	10 0 0
Tees	11 8 0	11 0 0
Joists	10 8 0	10 0 0
Channels	10 13 0	10 5 0
Rounds, 3in. and up	11 8 0	11 0 0
„ under 3in.	11 15 0‡	11 0 0
Plates, ¼in. (basis)	10 10 6	10 2 6
„ 5/16in.	10 15 6	10 7 6
„ ⅜in.	11 0 6	10 12 6
„ 7/16in.	11 5 6	10 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6
Boiler Plates, ¼in.	11 8 0	11 12 6
Midlands, and Leeds and District—		
Angles	10 8 0	10 0 0
Tees	11 8 0	11 0 0
Joists	10 8 0	10 0 0
Channels	10 13 0	10 5 0
Rounds, 3in. and up	11 8 0	11 0 0
„ under 3in.	11 16 0‡	11 0 0
Flats, 5in. and under	11 15 0‡	11 0 0
Plates, ¼in. (basis)	10 13 0	10 2 6
„ 5/16in.	10 18 0	10 7 6
„ ⅜in.	11 3 0	10 12 6
„ 7/16in.	11 8 0	10 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6
Boiler Plates, ¼in.	11 10 6	11 12 6

STEEL (*continued*).

	*Home. £ s. d.	†Export. £ s. d.
Glasgow and District—		
Angles	10 8 0	10 0 0
Tees	11 8 0	11 0 0
Joists	10 8 0	10 0 0
Channels	10 13 0	10 5 0
Rounds, 3in. and up	11 8 0	11 0 0
„ under 3in.	11 15 0‡	11 0 0
Flats, 5in. and under	11 15 0‡	11 0 0
Plates, ¼in. (basis)	10 10 6	10 2 6
„ 5/16in.	10 15 6	10 7 6
„ ⅜in.	11 0 6	10 12 6
„ 7/16in.	11 5 6	10 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6
Boiler Plates, ¼in.	11 8 0	11 12 6
South Wales Area—		
Angles	10 8 0	10 0 0
Tees	11 8 0	11 0 0
Joists	10 8 0	10 0 0
Channels	10 13 0	10 5 0
Rounds, 3in. and up	11 8 0	11 0 0
„ under 3in.	11 15 0‡	11 0 0
Flats, 5in. and under	11 15 0‡	11 0 0
Plates, ¼in. (basis)	10 13 0	10 2 6
„ 5/16in.	10 18 0	10 7 6
„ ⅜in.	11 3 0	10 12 6
„ 7/16in.	11 8 0	10 17 6
Un. 7/16in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6

Ireland—f.o.q.	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	10 13 0	10 15 6
Tees	11 13 0	11 15 6
Joists	10 13 0	10 15 6
Channels	10 18 0	11 0 6
Rounds, 3in. and up	11 13 0	11 15 6
„ under 3in.	12 0 0‡	12 2 6
Plates, ¼in. (basis)	10 15 6	10 18 0
„ 5/16in.	11 0 6	11 3 0
„ ⅜in.	10 5 6	11 8 0
„ 7/16in.	11 12 6	12 10 0
Un. 7/16in. to ¼in. incl.	11 12 6	11 12 6

‡ *Rounds and Flats tested quality; untested, 3s. less.*

OTHER STEEL MATERIALS

Sheets.	Home. £ s. d.	Export, f.o.b. £ s. d.
11-G. and 12-G., d/d	13 15 0	11-G. to 14-G. 11 5 0
13-G., d/d	14 2 6	15-G. to 16-G. 11 15 0
14-G. to 20-G., d/d	14 10 0	17-G. to 18-G. 12 0 0
21-G. to 24-G., d/d	14 15 0	19-G. to 20-G. 12 5 0
25-G. and 26-G., d/d	15 10 0	21-G. to 22-G. 12 17 6

South Africa, Rhodesia, Nyasaland, £14; Canada, £14 12s. 6d., f.o.b. basis. Irish Free State, £14 15s., f.o.q., 4-ton lots.

The above home trade sheet prices are for 4-ton lots and over; 2-ton to 4-ton lots, 7s. 6d. per ton extra; and under 2-ton lots to 10-cwt., £2 per ton extra.

Galvanised Corrugated sheets, basis 24-G.—

Home.	£ s. d.
4-ton lots and up	17 5 0
2-ton to 4-ton lots	17 12 6
Under 2 tons	18 17 6

Export: India, £17 15s. c.i.f.; Irish Free State, £17 5s., f.o.q.; General, £15 15s., f.o.b., 24-G. basis.

Tin-plates— 20 by 14 basis, f.o.t., Bristol Channel Ports, 20s. 4½d. Tin-plate Bars, d/d Welsh Works, £7 5s.

Billets—100-ton lots and over, 35 to 100 tons, 5s. extra; less than 35 tons, 10s. extra.

	£ s. d.
Soft (up to 0·25% C.), untested	7 7 6
„ „ „ tested	7 12 6
Basic (0·33% to 0·41% C.)	7 17 6
„ Medium (0·42% to 0·60% C.)	8 10 0
„ Hard (0·61% to 0·85% C.)	9 0 0
„ „ (0·88% to 0·99% C.)	9 10 0
„ „ (over 0·99% C.)	10 0 0
Rails, Heavy, 500-ton lots, f.o.t.	9 10 0
„ Light, f.o.t.	8 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	4/5 per lb.	
Ferro-Tungsten	4/4 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 10 0	7/6
„ „ 6 p.c. to 8 p.c.	£23 5 0	7/6
„ „ 8 p.c. to 10 p.c.	£23 5 0	7/6
„ „ Max. 2 p.c. carbon	£36 0 0	11/-
„ „ „ 1 p.c. carbon	£38 5 0	11/-
„ „ „ 0·5 p.c. carbon	£41 0 0	12/-
„ „ „ carbon-free	10d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose), 76 p.c.	£16 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 10 0 scale 5/- p.u.	
„ „ 75 p.c.	£17 0 0 scale 6/- p.u.	
„ Vanadium	14/- per lb.	
„ Molybdenum	4/10 per lb. 5/- forward	
„ Titanium (carbon-free)	9d. per lb.	
Nickel (per ton)	£185 to £190 per ton	
Cobalt	8/6 to 8/9 per lb.	

NON-FERROUS METALS.

(*Official Prices, July 26th.*)

Copper—	
Cash	£43 0 0 to £43 1 3
Three Months	£43 5 0 to £43 6 3
Electrolytic	£49 0 0 to £49 10 0
Best Selected Ingots, d/d Birmingham	£49 5 0
Sheets, Hot Rolled	£80 0 0

	Home.	Export.
Tubes, Solid Drawn (basis)	12¾d.	12¾d.
„ Brazed (basis)	12¾d.	12¾d.

Brass—	
Ingots, 70/30, d/d Birmingham	£38 10 0

	Home.	Export.
Tubes, Solid Drawn 2/1 Alloy	11½d.	11½d.
„ Brazed	13½d.	13½d.

Tin—	
Cash	£229 17 6 to £230 0 0
Three Months	£224 15 0 to £225 0 0
Spelter—	
Cash	£14 6 3 to £14 8 9
Three Months	£14 10 0 to £14 11 3
Lead—	
Cash	£14 13 9 to £14 15 0
Three Months	£14 15 0 to £14 16 3
Aluminium Ingots (British)	£94 (net)

FUELS.

SCOTLAND

	Export.
Lanarkshire—	
(f.o.b. Grangemouth)—	
Navigation Unscreened	18/- to 18/6
Hamilton Ell	17/6
Splints	20/-
Ayrshire—	
(f.o.b. Ports)—	
Steam	17/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	18/-
Unscreened Navigation	18/6
Lothians—	
(f.o.b. Leith)—	
Hartley Prime	18/-
Secondary Steam	16/9

ENGLAND

South Yorkshire, Doncaster—	
Steam Hards	19/- to 20/-
Washed Smalls	16/- to 17/-
Northumberland, Newcastle—	
Blyth Best	19/- to 19/6
„ Second	18/- to 18/6
„ Best Small	15/6
Unscreened	17/- to 18/-
Durham—	
Best Gas	19/6
Foundry Coke	26/- to 28/-

SOUTH WALES

Cardiff—	
Steam Coals:	
Best Admiralty Large	23/6 to 24/-
Best Seconds	23/- to 23/6
Best Dry Large	23/- to 23/6
Ordinaries	23/-
Bunker Smalls	16/- to 17/6
Cargo Smalls	15/- to 15/6
Dry Nuts	27/6 to 28/-
Foundry Coke	35/- to 42/6
Furnace Coke	30/- to 33/6
Patent Fuel	25/6
Swansea—	
Anthracite Coals:	
Best Large	36/- to 38/-
Machine-made Cobbles	41/- to 45/6
Nuts	40/- to 45/-
Beans	33/- to 38/6
Peas	26/- to 30/-
Rubbly Culm	15/- to 16/-
Steam Coals:	
Large Ordinary	22/6 to 24/6

FUEL OIL.

Inland consumption: contracts in bulk.

Exclusive of Government tax of 1d. per gallon; and 9d. per gallon on oil for road vehicles.

Ex Ocean Installation—	Per Gallon.
Furnace Oil (0·950 gravity)	3¾d.
Diesel Oil	4¼d.

French Engineering Notes

(From our own Correspondent in Paris)

Civil Defence

THE Government has now centralised civil defence organisation in the hands of the Minister of National Defence, whose services include a military staff and a department of civil defence. The Ministry is preparing a general plan which will constitute a basis for all programmes of civil defence work undertaken by public and private bodies throughout the country. The plan provides for permanent defensive measures which it would take several years to complete at great cost, and as this obviously cannot be done in all cases it is required that the programmes of works submitted to the Minister of National Defence for approval, modified by conditions of time and the money available for carrying them out, must fit in with the plan as far as possible. In addition to this central organisation there are regional organisations, each under the prefect of the department who will be directly under the Minister's orders. The prefect will have as adviser the general commanding the military region, and he will be assisted by mayors and a departmental commission of civil defence which will be created. The central body is national and the regional organisations local, the prefect having the assistance of all the authorities and services in his department. He receives instructions from the Minister respecting work to be undertaken by public and private bodies, who must take the plan as a guide for any modifications they may want to make. As the plan covers civil defence in every detail it is not expected that the departments will be able to finance the works in the order of importance suggested. In the instructions just published there is no clear indication of the State contribution to the cost, but the plan as a whole will provide estimates, and it is stated that the programmes of works presented for approval must be within the limits of financial possibilities. All the programmes will be approved by the central technical committee.

The Garabit Viaduct

The commemoration last week of the opening of the Garabit railway viaduct fifty years ago could only be justified for a particular reason, which was its construction by Gustave Eiffel almost contemporaneously with the tower in Paris that bears his name. Both constructions aroused the same surprised interest and doubts whether their apparent lightness was not obtained by a sacrifice of resistance. There was so little confidence in the Garabit viaduct that it was subjected to tests for four years before a regular passenger train service was allowed to start in 1889. Since then it has not been found necessary to do any work on the viaduct, which has, nevertheless, had to resist violent winds that occasionally sweep down the valley. Carrying a railway over the Truyère valley not far from the town of Saint-Flour, in the department of Cantal, the viaduct has a total length of 1466ft., supported by an arch with a span of 541ft. The parabolic arch springs from stone abutments, and its central height from the river is 406ft. On these abutments rise standards to the railway platform, with two shorter supports on the arch itself. Beyond the arch the railway is carried on three similar standards on the rising side of the valley. There is an appearance of lightness and fragility about the structure, notwithstanding the 3326 tons of steel. It is of open-girder construction, the arches and standards being broad at the base and narrowing to the width of the platform. Any sense of lateral stability is lost except when the viaduct is viewed endways. It is regarded as a unique example of a metallic viaduct fitting in harmoniously with picturesque surroundings, and while nowadays there is nothing abnormal in the design and construction, no one appears to have used the steel then available in the same manner before Gustave Eiffel built the viaduct. Only a few days before this commemoration there was a less spectacular ceremony, when the Pont de la Caille attained its centenary. This suspension bridge crosses a deep gorge in the Haute-Savoie on the road between Annecy and Geneva. Its construction was ordered to be undertaken by the Duc de Savoie to the designs of Monsieur E. Bertin. There are two groups of six cables, 984ft. long and anchored in the rock to a depth of 33ft. From the cables are suspended joists upon which the roadway is laid. This roadway is 492ft. above the torrent of the Usses. At each end of the bridge is a gateway with two towers 65ft. high. It was opened in July, 1839, with great ceremony. In 1930 a reinforced concrete bridge built alongside was put into service, and since then the old suspension bridge has been used exclusively by pedestrians. They offer a striking example of a century's progress in bridge construction.

The Liner "Pasteur"

The liner "Pasteur," which replaces the ill-fated "Atlantique" on the service between Bordeaux and South America, left the construction dock at Saint-Nazaire on Thursday of last week for trials before proceeding to her home port of Bordeaux. She is a departure from ideas that led to the construction of the "Atlantique," which was intended to raise the prestige of the French merchant marine in South America by means of a ship that would outclass every other in that service in size, speed, and luxurious accommodation, but the failure of the "Atlantique" to attract anything like the number of passengers necessary to cover running costs turned attention to a smaller type of ship offering the maximum of comfort and convenience within commercial possibilities. Having a length of 695ft. and a width of 88ft. 6in., the "Pasteur" has a displacement of about 30,000 tons, and with engines of nearly 70,000 H.P. is expected to reach a speed of 26 and possibly 27 knots. She represents the latest type of ship in service and is, in fact, the only big passenger ship launched in France since the "Normandie," which she resembles in her general lines, except for the single funnel and the derricks aft for handling cargoes. After recent experience French naval architects have concentrated still more on precautions against fire which have been carried out as far as is humanly possible. The putting into service of the "Pasteur" will allow of the withdrawal of the 16-knot "Massilia," which, despite her age, has carried on since the burning of the "Atlantique."

British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

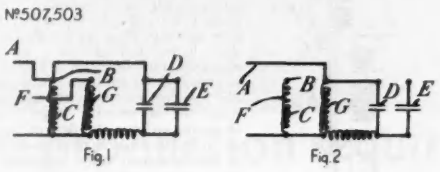
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS

507,503. December 16th, 1937.—ELECTRIC MOTORS, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2; Arthur Hemborough Maggs, of 14, Oval Road, and Shafi-Uddin Ahmed Choudhury, of 36, Manor Road, both of Rugby.

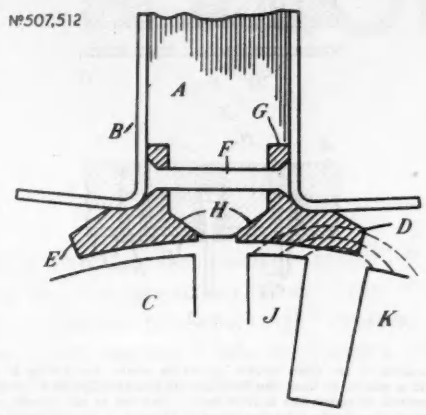
The objects of this invention are to provide a capacitator motor having any required starting torque within a wide range with a value of starting current which is almost directly proportional to the required torque, and to provide a capacitator motor having a high value of starting torque per volt-ampere taken from the line, irrespective of the torque required. One of the schemes described in the specification is shown in Figs. 1 and 2. Fig. 1 shows the starting connections. The line A is connected to the free end terminal B of the auto-transformer winding C, and to the free terminals of the condensers D and E,



and the tapping point F of the auto-transformer winding is connected to the free terminal of the main winding G. Thus the main winding has applied to it a voltage lower than the line voltage, whereas the full-line voltage is applied to the auxiliary circuit in which the two condensers are in parallel. In Fig. 2, which shows the running connections, the line A is now connected directly to the free terminal of the main winding and to the free terminal of the running condenser D, having been disconnected from the terminal B of the auto-transformer winding and from the starting condenser E. The tapping point F of the auto-transformer winding has also been disconnected from the free terminal of the main winding; hence the auto-transformer is out of circuit. Thus the full-line voltage is now applied to the main winding as well as to the auxiliary circuit, and the effective capacitance in series with the auxiliary winding is less than when starting.—*June 16th*, 1939.

507,512. January 21st, 1938.—COMMUTATOR DYNAMOS WITH INTERPOLES, Arnold Tustin, of 41, Botanical Road, Sheffield, 11, and Metropolitan-Vickers Electrical Company, Ltd., of Number One, Kingsway, London, W.C.2.

It is well known that with some dynamo machines, although interpoles are provided, a completely sparkless commutation is not obtained and this is mainly due to sparks occurring at the time when the last conductor in a slot is finishing commutation. The object of the invention is to provide improved means for reducing changes in the flux linking the conductor, which passes between the tops of the teeth through the air gaps outside the armature surface, thereby reducing the effective inductance of the conductors at the moment of rupture of the current passing through them, and so that the increasing resistance of the contact will eliminate the arc produced on rupture. A is the interpole core, B the spool for the interpole winding, and C the armature of the machine. Damper brass D and E,

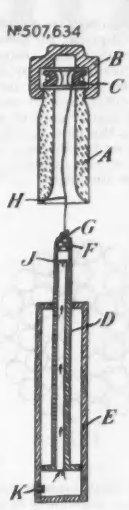


constructed of copper, are located on either side circumferentially of the armature, and are secured to the interpole by rivets F. It will be observed that the interpole is stepped at G and chamfered at H. This has the effect of securely locating the damper bars and, in addition, of providing a tapered interpole tip. In the arrangement shown it is assumed that the last conductor in the slot between the teeth J and K is completing commutation. There will be an intertooth flux which will extend outwards beyond the armature periphery and is indicated to some extent by the dotted lines. This flux will be maintained whilst the several conductors in the slot are undergoing commutation, but will tend to change as the last conductor completes commutation. The damper bar D intersects this flux, so that eddy currents will be induced in the bar, which will tend to oppose changes in the tooth flux and so reduce the effective inductance of the conductor undergoing commutation. The damper bar D is mainly effective during rotation in a clockwise direction, whilst the damper bar E is mainly effective during rotation in a counter-clockwise direction.—*June 16th*, 1939.

SWITCHGEAR

507,634. December 16th, 1937.—ELECTRIC SWITCHES WITH ARC-GENERATED GAS BLAST, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.

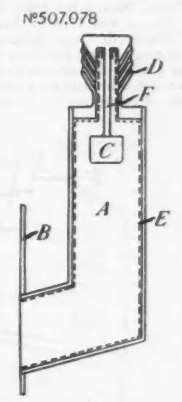
According to the invention the movable contact of a switch is so constructed as to produce by its movement an auxiliary gas blast suitable for the suppression of small current arcs. A is a switch tube of gas-yielding material closed at one end by the contact chamber B containing the fixed switch contact C. The movable switch contact assembly co-operating with the fixed contact consists of the hollow contact rod D movable in the guide tube E. The parts D E together form a device for producing an additional gas blast for the suppression of arcs formed when small currents are interrupted. This gas blast is produced by the compression which occurs in tube E when contact rod D is moved to open circuit and flows through the hollow contact and emerges at its point through an annular jet F. In this way the gas blast is directed to an arcing tip G so that the foot point of the arc H is subjected to an intensive gas blast whereby it is extinguished. The suppression of the arcs due to the interruption of large and medium currents is effected by the gas blast produced by the action of such arcs on the switch tube A. If this gas were allowed to pass into the interior of the hollow contact rod D it would tend to slow up the opening movement of the contact as the pressure produced would act on the lower flanged end of the contact rod. This condition might occur when the upper end of rod D is still within the tube A. This is prevented by means of non-return valve J. The guide tube F is also preferably provided with a similar valve K, which prevents a reduced pressure from being present in tube E during closure of the switch.—*June 16th*, 1939.



TRANSFORMERS AND CONVERTERS

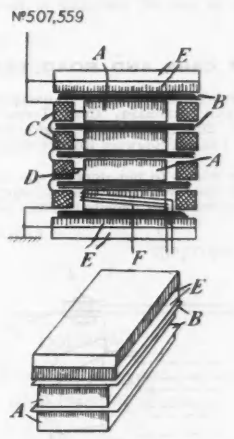
507,078. December 15th, 1937.—VAPOUR ELECTRIC DISCHARGE APPARATUS, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.2, and Enrico Gallizia, of The General Electric Company, Ltd., Engineering Works, Witton, Birmingham.

According to this invention, in pumpless vapour electric discharge apparatus having one or more side arms, part or the whole of the inside surface of a side arm or like anode housing is vitreous enamelled. The inside surface of a side arm or similar anode housing may be vitreous enamelled only in the vicinity of the anode contained therein. In the example shown the side arm A is attached in known manner with a number of similar side arms (not shown) to the main tank B of a converter and an anode C is supported within the side arm by a seal D comprising metallic members united by vitreous material. The inside surface of the side arm is completely coated with a layer E of vitreous enamel, and the layer also extends over the inside surface of the seal D and a short way down the stem F of the anode. In this manner the inside surface of the side arm A is provided with an insulated surface which renders the formation of discharges and cathode spots on the walls of the side arm more difficult. The danger of backfire is thereby reduced.—*June 9th*, 1939.



507,559. November 17th, 1937.—ELECTRIC CHOKES OR VOLTAGE TRANSFORMERS, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C.2.

The transformer described in this specification comprises an iron core subdivided into several core sections A arranged in layers over one another and insulated from one another by insulating layers B. For bringing about a uniform voltage drop these layers are connected with adjacent disc coil sections C of the high-voltage winding by means of electrical connections D, the insulation B in the form of insulating discs or plates extending also between the disc coil sections. The column formed in this manner is supplemented by flat-yoke end sections

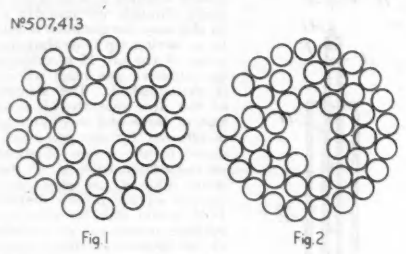


E, each yoke end being connected with the commencement or with the end of the high-voltage winding. The lowermost core section carries a low-tension winding F. A part of the core plates of the sections A is replaced by magnetically non-conducting material—for example, pressspahn—while the yoke-end sections E having a rectangular or square cross section, with a view to lowering the magnetic return circuit resistance, form subdivided end parts. These upper and lower subdivided end parts each comprise a pair of adjacent and vertically laminated plate-like members, as shown at E, the laminations of one member of the pair being arranged at right angles to those of the other member of the pair.—*June 16th*, 1939.

TRANSMISSION OF POWER

507,413. October 14th, 1937.—ELECTRIC CABLES, Allgemeine Elektricitäts-Gesellschaft, of 2–4, Friedrich Karl-Ufer, Berlin, N.W.40.

The invention relates to the production of sector-shaped or other non-circular cores, *e.g.*, oval or elliptical, for stranding together to form multi-conductor electric cables, especially high-tension cables. According to the invention, in producing a non-circular cable core a gap or gaps is, or are, left between some, or all, of the wires of at least the outer layer of stranded wires forming the core. By making this gap or gaps of appropriate size it can be ensured that, when the core is deformed into the non-circular shape, there is no undue increase in the periphery and thus no undue stressing of the insulation. In the conductor according to the invention illustrated in Fig. 1,

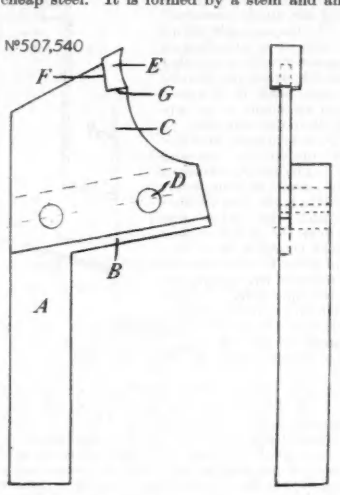


substantial intervening spaces are provided between all the wires of three layers. Fig. 2 shows another possibility in which, instead of there being a large number of small intervening spaces uniformly distributed between the wires of the same layer, a single space of the requisite size is left at one point in each layer. It is, if course, possible, instead of concentrating the entire intervening space at one point, to distribute it among two, three, or more points as desired. Conductors such as those of Figs. 1 and 2, however, will not have their perimeters enlarged, or only to a very limited extent, when they are deformed from a circular into a sector shape, because in these conductors there is possible not only a compression in the radial direction, but the wires of the individual layers of wire are able to come closer together in the peripheral direction of the conductor owing to the gaps which have been left.—*June 14th*, 1939.

MACHINE TOOLS AND SHOP APPLIANCES

507,540. November 18th, 1938.—CUTTING-OFF AND GROOVING TOOLS FOR USE IN LATHES, Henri Roger, of 11, Rue du Moulin de Cage, Gennevilliers, Seine, France.

Cutting-off and grooving tools for use in lathes have to make deep cuts in the article to be worked, and the purpose of this invention is to produce a cheap tool. The body A is the support, made of cheap steel. It is formed by a stem and an oblique

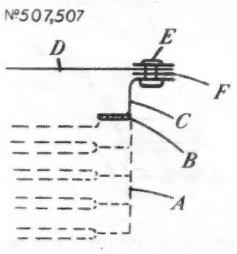


cross piece B, provided with a slot to receive the tool proper, in this case the thin end portion C, fixed on the cross piece B by bolts D. The tip E is composed of high-tensile steel placed in a rectangular notch or a V-shaped opening. In order that the weld on the surfaces F and G may be perfect, the inner corner of the tip may be cut off, according to known practice.—*June 16th*, 1939.

MOTOR CARS AND ROAD TRAFFIC

507,507. December 23rd, 1937.—RADIATORS FOR MOTOR VEHICLES AND AIRCRAFT, Cyril Terence Delaney, of "Belmont," 20, Brondesbury Park, London, N.W.6, and Gallay, Ltd., of Edgware Road, Cricklewood, London, N.W.2.

This invention relates to radiators for use upon aeroplanes, motor cars, and other vehicles. The radiator is of the kind in which a core or matrix is mounted within a shell. The core

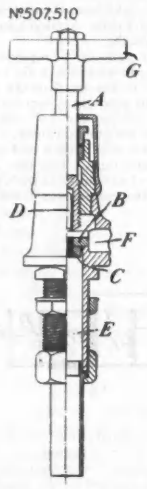


or matrix A is soldered, brazed, or similarly secured at B to part of a suitably shaped strip or piece of metal C. The shell or container D is riveted, screwed, or otherwise secured at E to another part of the piece of metal C. The part of the piece of metal in close proximity to the shell D is given a suitable protective coating, preferably by means of an electro-deposition process, in order to prevent corrosion or electrolytic action between the piece of metal C and the shell D. Jointing material F would be placed between the piece of metal C and the shell D when necessary to ensure a tight joint. In one construction the elements or tubes comprising the core or matrix A are made of brass, cupro-nickel, or other metal, whilst the shell D is of light alloy sheet. Between the core A and shell B is the piece of metal C. After shaping this metal it is "tinned" or given the customary preliminary coating of solder on the part to be attached to the core or matrix A. The metal C is now nickel or chromium-plated, the coating of tin preventing the deposition of the electro-plating upon the part so treated. The "tinned" part of the metal is soldered to the core or matrix and the other part is riveted to the shell with jointing F placed between the metal C and shell D to ensure a liquid or gas-tight joint.—*June 16th*, 1939.

MISCELLANEOUS

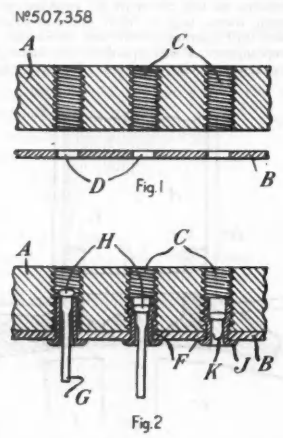
507,510. January 15th, 1938.—STOP COCKS, Barking Brassware Company, Ltd., and Werner Petzall, both of the company's address at River Road, Barking, Essex.

In the usual hot water supply installations which embody a mixing chamber to which hot and cold water pipes open, the cold water is at a higher pressure than is the hot water. In consequence, difficulties are experienced in obtaining correct mixture of the hot and cold water. An object of the invention is to avoid the difficulties in a simple and efficient manner. A water cock in accordance with the invention comprises a screw-threaded valve spindle A carrying at its end a washer B secured by a nut C in screw-threaded engagement with a member D arranged to move up and down with the spindle. The washer B and nut C control the flow of water from a pipe E into a duct F which leads to a mixing chamber (not shown). A handle G is provided for rotation of the spindle A. The nut C is tapered and made of sufficiently large outer diameter to give the desired result of first allowing a restricted flow of water which only increases to the value which, without the modified form of nut, the washer by its position would permit, after the spindle has been turned to a predetermined extent in its opening movement. The taper at the part of the nut immediately adjacent the washer may be less than at the adjacent part further from the washer, so that when the tap is first opened the rate of flow of water increases less rapidly for a given angular movement of the spindle than is the case when the opening movement of the tap has proceeded for some determined time.—*June 16th*, 1939.



507,358. March 12th, 1938.—IMPROVEMENTS RELATING TO THE SECURING OF SHEET METAL OR OTHER PARTS TO STRUCTURAL MEMBERS, A. V. Roe and Co., Ltd., of Newton Heath, Manchester, 10, and Roland Foster Taylor, of the same address.

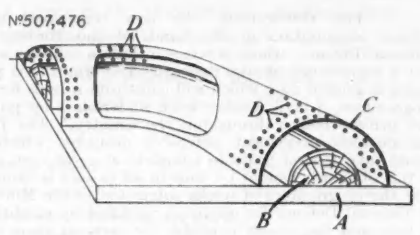
In accordance with this invention the members A to which the thin skin, metal plates, or fittings B are to be applied, are drilled with holes C which may go completely through the members A or may be blind holes. In either case, these holes C are then tapped. The thin skin, metal plate, or fitting B is drilled with holes D spaced to correspond with the holes C in the structural members A and "pop rivets," or other similar type rivets—that is to say, headed hollow rivets F, each having a bore through which a headed mandrel G is drawn, the bore being of smaller diameter than the head H of the mandrel G—are then inserted through the holes D into the holes C. The



mandrels G are then drawn outwards whilst the rivets F are held in place, so that the bevelled or rounded heads H on the mandrels G enter the hollow body portions of the rivets and expand the rivets into the threads tapped in the walls of the holes C, so causing an intimate and firm engagement with the structural members, the thin skin, metal plate, or fitting B being held beneath the rivet heads J. The mandrels G fracture within the rivets, as shown at K in Fig. 2, leaving the mandrel heads H embedded in the rivets. The mandrel heads H may come outside the structural members A if the rivets extend completely therethrough. Alternatively, the mandrel may be drawn right through the rivet, as it is not essential for the mandrel head to be left inside the rivet, and the mandrel may then, if desired, be used again. The rivets and structural members may be made of the same metal, such as light alloy, or of dissimilar metals, or of any suitable combination of metals.—*June 14th*, 1939.

507,476. October 15th, 1937.—HEAT OR SOUND-INSULATING BODIES, Chance Brothers and Co., Ltd., of Glass Works, Smethwick, Birmingham, and Alfred Lindsay Forster, of Glasgow Glass Works, Firhill, Glasgow.

This invention has for its object to facilitate the manufacture from fibrous materials, such as spun glass, of heat or sound-insulating bodies of complex shapes, such as coverings for pipe bends or junctions, valve coverings, and other analogous bodies which cannot readily be made by bending flat sheets of the insulating materials. The mould shown is suitable for the manufacture of heat-insulating coverings for pipe bends, &c., and is composed of a base plate A, a core or inner wall B mounted on the base plate, and an outer wall C, also mounted on the base plate, the outer wall being arranged over and spaced from the core or inner wall. The outer wall C is made from perforated sheet metal, wire mesh, or any other convenient perforated material, whilst the core or inner wall B is solid, or is also made from perforated sheet metal, wire mesh, or similar perforated material. Both the core or inner wall B and the outer wall C are shaped to a semi-circular form in cross section and to a curved form in the direction of their lengths. The



glass or like fibrous material is carried into the mould through one or each end by a current of air supplied by a blower or any other convenient means, and the effluent air escapes through the wall perforations D, leaving the fibres in a compact mass within the mould. When the fibrous material is supplied through one end only of the mould, the other end is closed in any suitable manner.—*June 15th*, 1939.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

British Waterworks Association

To-day and Saturday, July 28th and 29th.—Summer meeting at Nottingham.

Institution of Electrical Engineers

Friday to Sunday, Sept. 15th to 17th.—TRANSMISSION SECTION. Summer visit to Yorkshire.

Institution of Mechanical Engineers

Saturday to Sunday, August 26th to October 1st.—American Summer meeting.

PERSONAL AND BUSINESS ANNOUNCEMENTS

THE INSTITUTION OF CHEMICAL ENGINEERS informs us that as from July 22nd its telephone number has been Victoria 6161/2.

WE are pleased to announce that the Honorary Degree of Doctor of Science of the University of Wales was conferred on Mr. H. L. Guy at Aberystwyth University College on July 18th.

THE QUASI-ARC COMPANY, LTD., announces that as from July 22nd its offices have been transferred to the following address:—Bilston, Staffs. Telephone No., Bilston, 41714; telegraphic address, "Quazarc, Bilston."

GENERAL REFRACTORIES, Ltd., Genefax House, Sheffield, informs us that Mr. W. G. Girling, who is vice-chairman and managing director of Henry Foster and Co., Ltd., an associated company, has been appointed a director of the company and also of the Glenboig Union Fire Clay Company, Ltd., Scotland.

MESSRS. PREECE, CARDEW AND RIDER inform us that they have taken into partnership Mr. John Bell, who has been on their staff for many years, and Mr. Cecil Henry Pickworth, a former member of the staff and late electrical engineer-in-chief, Public Works Department, Nigeria. There will be no alteration in the firm's title.

SANDERSON AND CO. (TEXTILE ENGINEERS), Ltd., of 5, Cross Street, Manchester, textile engineers, announce that they have been appointed sole agents in the North of England for the Myford Engineering Company, Ltd., Beeston, Nottingham, for the purpose of distributing the machine tools made by that firm to production plants and trade users.

EDUCATIONAL INTELLIGENCE

THE fourth session of the British Foundry School closed on July 26th. The annual meeting of the School took place at the Education Offices, Margaret Street, Birmingham, at 2.30 p.m. on Tuesday, July 25th, and all interested were invited to attend. The new session of the School will open on September 19th next, and applications for admission can now be received. Forms can be obtained from the Secretary of the School, at the Central Technical College, Suffolk Street, Birmingham, from whom any further information can be obtained.

CATALOGUES

REVVO CASTOR COMPANY, Ltd., Archdale Works, Blechynden Street, London, W.11.—List No. 10 of ball bearing castors.

LEA RECORDER COMPANY, Ltd., Cornbrook Park Road, Manchester, 15.—Reprint of a lecture on "The Standing Wave Flume," by Mr. J. W. Horner.

HENRY WIGGIN AND CO., Ltd., Thames House, Millbank, S.W.1.—"Monel: An Account of its Properties, Principal Uses, Fabrication, and Available Forms."

ALUMINIUM UNION, Ltd., The Adelphi, Strand, London, W.C.2.—A new book, entitled "Aluminium Alloys: Their Characteristics and Applications in Wrought Form."

ENGLISH STEEL CORPORATION, Ltd., Vickers Works, Sheffield.—A booklet describing the composition, properties, and application of "Escaloy" cemented carbide tips and tools.

SIEMENS ELECTRIC LAMPS AND SUPPLIES, Ltd., 38–39, Upper Thames Street, London, E.C.4.—Catalogue of telephone and signalling systems particularly adapted for A.R.P. requirements.

ROSE, DOWNS AND THOMPSON, Ltd., 28, Victoria Street, London, S.W.1.—An illustrated leaflet, forming list No. 33 of the firm's general oil mill catalogue, describing oil mill kettles or cookers.